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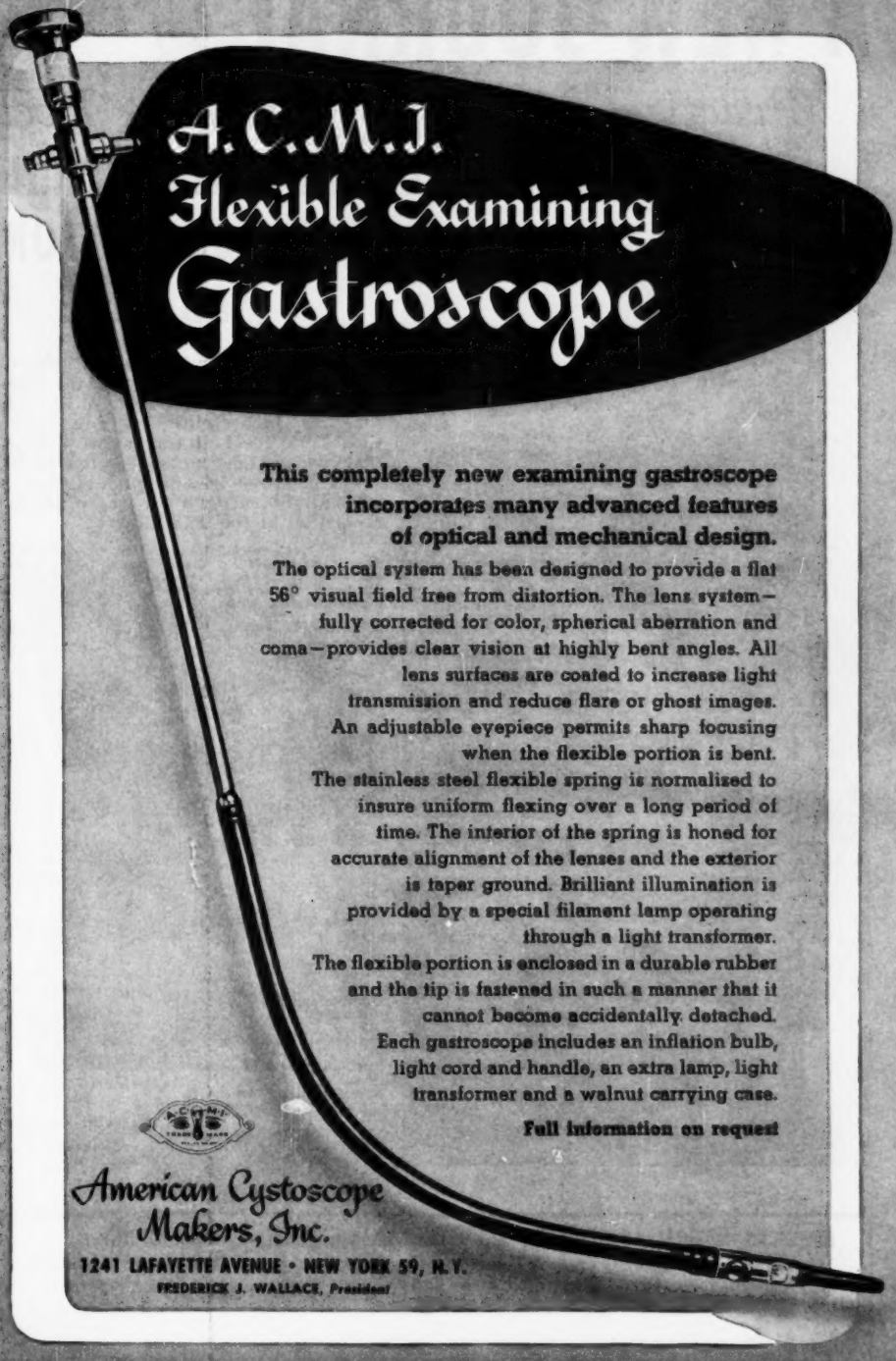

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EFFECT OF VAGOTOMY ON GASTRIC SECRETION IN MAN AND EXPERIMENTAL ANIMALS

EDWARD R. WOODWARD, M.D.

PAUL V. HARPER Jr., M.D.

E. BRUCE TOVEE, M.D.

AND

LESTER R. DRAGSTEDT, M.D.

CHICAGO

THE PRESENCE of gastric secretory fibers in the vagus nerves and the activation of these nerves by conditioned and unconditioned reflexes involving the sight, odor, taste or thought of food were established by the classic researches of Pavlov and his associates. Pavlov considered the secretory fibers in the vagi to be the most important mode of activation of the gastric glands and was doubtful if gastric secretion could occur after these nerves had been divided. The work of numerous English and American physiologists has, however, subsequently demonstrated that an abundant secretion of gastric juice of normal composition can occur after complete vagotomy in experimental animals, and the mechanism of this secretion has been extensively studied. The contact of food substances with the mucosa of the stomach and intestine is thought to cause the elaboration of a chemical substance which is absorbed into the blood stream and stimulates the gastric glands to increased activity. The mucosa of the antrum of the stomach was thought by Edkins to be particularly important in this connection, and he believed that the gastric stimulant provided by the antrum mucosa in response to the stimulus of food was a hormone for which he suggested the name gastrin. While both nervous and chemical factors are now well recognized to play a role in the physiology of gastric secretion, the relative importance of these factors has not been investigated. The widespread use of chemical stimuli such as histamine and alcohol in studying gastric secretion in patients with ulcer has perhaps overemphasized the importance of the humoral or chemical mechanism in the minds of many observers. It is difficult to subject gastric glands of man or intact animals to the stimulus of food and make a quantitative collection

From the Department of Surgery of the University of Chicago.

This work has been aided by grants from the Otho S. A. Sprague Memorial Institute, from the Division of Research Grants and Fellowships of the National Institute of Health, United States Public Health Service and from the Douglas Smith Foundation for Medical Research of the University of Chicago.

of the gastric secretory response. A fairly quantitative collection of the continuous gastric secretion in the empty stomach of man between meals, as at night, can be accomplished by means of the indwelling gastric tube combined with continuous suction. Data on the gastric secretion in response to the ingestion of food, for the most part, must be secured on experimental animals provided with a Pavlov pouch or with a totally isolated stomach.

The widespread employment of gastric vagotomy in the treatment of peptic ulcer and the probability that this procedure depends for its beneficial effect on a reduction in gastric secretion have made it important to determine the relative importance of nervous and chemical factors in the control of gastric secretion in health and disease. Questions that come to mind are the following: How much does complete division of the vagus nerves to the stomach decrease gastric secretion in normal animals and in patients with ulcer? Does a partial interruption of the secretory fibers to the stomach produce a partial decrease in the nervous phase of gastric secretion, or must the vagotomy be complete? The studies to be reported in this paper were conducted in an attempt to provide answers for these questions.

CLINICAL STUDIES

The work of the older clinicians demonstrated that most patients with duodenal ulcers secrete more gastric juice in response to a test meal than do normal persons. Intermittent aspiration of the gastric content in the intervals between meals likewise indicated that the continuous or basal secretion of gastric juice was usually increased in these patients. In 1942 study of the volume and acidity of the nocturnal gastric secretion in patients with ulcer by means of an intranasal gastric tube with continuous suction was introduced as a routine in this service, and as a substitute for the various types of test meals or of alcohol or histamine stimulation. In 1944 [1] it was reported that an excessive continuous secretion of gastric juice occurred in patients with duodenal ulcer and that this was reduced to normal or subnormal values by complete vagotomy. The method used at present for collecting the twelve hour night secretion is as follows: The patient is prepared for the test by the use of a clear liquid diet for twelve hours in the preoperative period and thirty-six to forty-eight hours in the postoperative period. At 8 o'clock in the evening a Levin tube is passed into the stomach, and, if feasible, the position of the tube checked fluoroscopically. Ideally, the tube should pass through the cardia of the stomach, lying flat on the lesser curvature without kinks, and should extend deep into the fundus just short of the angulus. When it is correctly placed

1. Dragstedt, L. R.; Palmer, W. L.; Schafer, P. W., and Hodges, P. C.: Gastroenterology **3**:450, 1944.

and is functioning properly, the stomach is completely aspirated and the tube connected with a continuous suction apparatus. Continuous gastric aspiration is maintained from 8:30 p. m. to 8:30 a. m. the following morning. In addition to determining the volume and free acidity of this fasting gastric secretion, we have calculated the twelve hour output of free hydrochloric acid, expressing the result in milliequivalents of hydrochloric acid. Since free acidity as expressed in clinical units is synonymous with milliequivalents per liter, the volume of gastric juice secreted expressed in liters multiplied by the free acidity in clinical units equals the milliequivalents of free hydrochloric acid secreted in the twelve hour period. This figure will be referred to as the hydrochloric acid output. Levin, Kirsner, Palmer and Butler [2] have recently reported on a series of normal persons in whom the twelve hour nocturnal

TABLE 1.—*Twelve Hour Night Gastric Secretions of 135 Patients with Ulcer and 33 Normal Persons*

Volume in Cubic Centimeters														
Percentage of Patients														
Range	**0**	**200**	**400**	**600**	**800**	**1,000**	**1,200**	**1,400**	**1,600**	**1,800**	**2,000**	**2,200**	**2,400**	**Average**
Ulcer	..	2	6	18	16	28	11	9	6	1	2	1	..	1,085
Normal	6	21	31	27	9	6	..	..	..	..	..	..	..	581
Free Acidity in Clinical Units														
Percentage of Patients														
Range	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**			**Average**
Ulcer	..	6	12	9	11	14	21	13	8	4	2	..	..	55
Normal	21	15	18	22	12	3	3	3	..	3	..	..	..	31
Hydrochloric Acid Output in Milliequivalents														
Percentage of Patients														
Range	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**110**	**120+**	**Average**
Ulcer	..	2	7	11	13	12	12	10	7	9	6	5	6	60
Normal	43	33	9	6	..	6	..	..	..	3	..	..	..	18

gastric secretion has been determined in this quantitative fashion. Table 1 shows this group of normal persons compared with a series of 135 patients with duodenal ulcer. The average volume in the former was 581 cc. in twelve hours, while in the group with ulcer the average was 1,085 cc., approximately twice as great. The average free acidity in the normal persons was 31 clinical units, and in the group with ulcer it was 55 clinical units. When the hydrochloric acid output is calculated, the difference is more striking. The average normal hydrochloric acid output was 18 milliequivalents, while that in the group with ulcer was 60, a nearly fourfold difference. Eighty-five per cent of the patients with duodenal ulcer secreted more than 35 milliequivalents of hydrochloric acid in the twelve hour period, and 85 per cent of the normal persons secreted less than 35 milliequivalents.

2. Levin, E.; Kirsner, J. B.; Palmer, W. L., and Butler, C.: Nocturnal Gastric Secretion, Arch. Surg. **56**:345 (March) 1948.

In addition, the twelve hour night gastric secretion was determined for 23 healthy inmates of the Illinois State Penitentiary. The results, as shown in table 2, have considerable interest, in that these subjects secreted nearly double the amount of hydrochloric acid that normal persons studied at this clinic secreted; their average output of hydrochloric acid in the twelve hour period was 30 milliquivalents, as compared with 18 milliequivalents in the normal group previously shown. It seems most likely that this increase in gastric secretion is neurogenic in origin and is related to the emotional tension and stress associated with imprison-

TABLE 2.—*Average 12 Hour Night Gastric Secretion*

	Number of Cases	Volume, Cc.	Free Acid, Clinical Units	Hydrochloric Acid Output, mEq.
Normal persons	33	581	31	18
Normal persons (in prison)	23	621	44	30
Patients with duodenal ulcer (before vagotomy)	70	1,006	52	55
Patients with duodenal ulcer (after vagotomy)	70	521	22	11

TABLE 3.—*Twelve Hour Night Gastric Secretion in 70 Patients Before and After Vagotomy*

	Volume in Cubic Centimeters													
Number of Patients														
Range	0	200	400	600	800	1,000	1,200	1,400	1,600	1,800	2,000	2,200	2,400	Average
Preoperatively	0	0	4	14	17	17	6	6	2	2	1	1	0	1,006
Postoperative	6	22	17	14	7	3	1	0	0	0	0	0	0	521

	Free Acidity in Clinical Units													
Number of Patients														
Range	0	10	20	30	40	50	60	70	80	90	100	..	..	Average
Preoperatively	0	6	11	9	10	7	11	9	6	1	..	..	..	52
Postoperative	20	19	14	6	6	4	0	0	1	0	..	..	..	22

	Hydrochloric Acid Output in Milliequivalents													
Number of Patients														
Range	0	10	20	30	40	50	60	70	80	90	100	110	120+	Average
Preoperatively	1	6	8	11	9	4	11	3	7	5	1	1	3	55
Postoperative	48	9	9	3	0	0	0	1	0	0	0	0	0	11

ment. It is interesting that there seems to be a high incidence of duodenal ulcer in the prison population.

That vagotomy produces a profound reduction in gastric secretion in patients with ulcer has been clearly demonstrated in previous reports from this clinic.[3] In this study quantitative studies of nocturnal gastric secretion were made for 70 patients with duodenal ulcer on whom vagotomy was performed between Jan. 18, 1943, and March 1, 1947.

3. Dragstedt, L. R., and Schafer, P. W.: Surgery **17**:742, 1945. Thornton, T. F.; Storer, E. H., and Dragstedt, L. R.: Supradiaphragmatic Section of Vagus Nerves, J. A. M. A. **130**:764 (March 23) 1946. Dragstedt, L. R.; Harper, P. V., Jr.; Tovee, E. B., and Woodward, E. R.: Ann. Surg. **126**:687, 1947.

Vagotomy was carried out by either the transthoracic or the transabdominal approach, but no additional surgical procedure was used in any of these patients. As shown in table 2, before vagotomy the average twelve hour volume was 1,006 cc., the average free acidity 52 clinical units and the average hydrochloric acid output 55 milliequivalents. After vagotomy, the average twelve hour volume was 521 cc., the average free acidity 22 clinical units and the average hydrochloric acid output 11 milliequivalents, a fivefold reduction in secretion. Table 3 shows these results in more detailed form. Figure 1 shows graphically the change in hydrochloric acid output produced by vagotomy in these 70 patients. It is noteworthy that only 20 of the 70 patients had com-

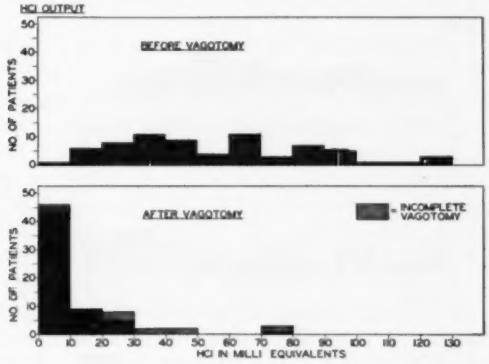

Fig. 1.—Twelve hour night gastric aspiration in 70 patients before and after vagotomy.

TABLE 4.—*Per Cent Reduction of 12 Hour Night Gastric Secretion in 70 Patients after Vagotomy*

Volume												
Range.....	0	10	20	30	40	50	60	70	80	90	100	Average
Number of patients.	4	4	8	7	7	10	14	10	6	0	0	53%
Free Acidity												
Range.....	0	10	20	30	40	50	60	70	80	90	100	Average
Number of patients..	5	2	8	2	8	5	7	9	13	11		61%
Hydrochloric Acid Output												
Range.....	0	10	20	30	40	50	60	70	80	90	100	**Average**
Number of patients..	4	1	0	0	4	6	6	7	10	32		76%

plete anacidity of the fasting twelve hour night secretion after vagotomy. It is interesting to compare the secretion of the vagotomized patients with that of normal persons (table 2). It is apparent that vagotomy

has reduced the fasting nocturnal secretion in these 70 patients with duodenal ulcer to normal or subnormal levels. Table 4 shows the per cent reduction in the twelve hour night gastric secretion produced by vagotomy. The average reduction in volume has been 53 per cent, in free acidity 61 per cent and in hydrochloric acid output 76 per cent. Figure 2 shows the same data graphically. In 87 per cent of cases there has been more than a 50 per cent reduction in hydrochloric acid output, and in 60 per cent there has been a reduction of over 80 per cent.

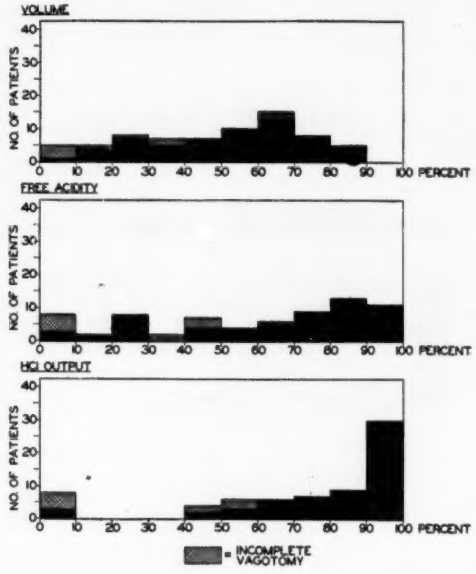

Fig. 2.—Per cent reduction of twelve hour night gastric secretion in 70 patients after vagotomy.

GASTRIC SECRETORY RESPONSE TO INSULIN HYPOGLYCEMIA: THE INSULIN TEST

The introduction of vagotomy as a clinical procedure has led directly to the development of clinical tests designed to evaluate the completeness and efficacy of the interruption of the vagal nervous pathways to the stomach. Vagotomy has been shown in the foregoing discussion to be most effective in reducing the acid secretion of the stomach of patients with duodenal ulcer in the absence of food or chemical stimuli. Historically this is the first clinical use of this effect in determining the completeness of vagotomy, and this test has been supplemented but not

supplanted by two other physiologic tests, the sham meal and the insulin test. The sham meal, which stems directly from the work of Pavlov, consists of exposing the patient to the sight, odor and taste of food under controlled conditions, while aspirating the stomach continuously with a Levine tube. To the best of our knowledge, this procedure has not been previously used as a clinical test except as reported from this clinic. The insulin test is based on the original observation of Bulatao and Carlson [4] that insulin hypoglycemia produced gastric hypermotility in dogs. This observation was confirmed and extended by other workers. The gastric hypermotility was found to be accompanied with hypersecretion of highly acid gastric juice rich in pepsin, and the effect was shown to be due to hypoglycemia and to be mediated through the vagus nerves.

The gastric secretory response to insulin hypoglycemia was used as a clinical test by Ihre [5] and Welin and Frisk [6] in Sweden in a manner similar to the use of the histamine test. Jemerin, Hollander and Weinstein [7] used the phenomenon to demonstrate the presence or absence of vagal innervation in the various types of gastric pouches in dogs, and Hollander suggested its use after vagotomy to determine whether or not the vagal pathways were in fact interrupted. It is the purpose of the present discussion to describe in detail the technics of these various tests as they are used in this clinic, point out the numerous pitfalls to which they are subject and which must be considered in evaluating each test and finally to correlate the results of the various tests, as well as our data permit, with the clinical findings.

The technic of the twelve hour night secretion study has been previously described. The insulin test or sham meal is generally used after this procedure with the help of the same Levin tube to which the patient has, by this time, become well accustomed. Placing of the tube is of great importance; this is usually best done under fluoroscopic control. The tip of the Levin tube should reach about the middle of the body of the stomach. If the tube is too far down, it may pass into the duodenum or through the gastroenterostomy stoma if one is present, thus vitiating the results of the test. Furthermore, a tube placed low in the stomach will be much more likely to collect samples contaminated with regurgitated bile or intestinal content, rendering the results of the test more difficult to interpret. Continuous aspiration is maintained

4. Bulatao, E., and Carlson, A. J.: Am. J. Physiol. **68**:148, 1924 and **69**:107, 1924.

5. Ihre, B. J. E.: Human Gastric Secretion, New York, Oxford Medical Publications, 1939.

6. Welin, G., and Frisk, R.: Acta med. Scandinav. **90**:543, 1936.

7. Jemerin, E. E.; Hollander, F., and Weinstein, V. A.: Gastroenterology **1**:500, 1943.

throughout the test with a glass or rubber bulb syringe. Usually this presents no problem, but not infrequently it is difficult to obtain adequate secretion for titration if the patient is not secreting well or if the Levin tube becomes occluded with food particles or folds of mucosa. Introduction of a small amount (20 to 30 cc.) of air through the tube and causing the patient to alter his position will almost always obviate these difficulties. Occasionally it is even possible to observe a periodic obstruction of the Levin tube caused by gastric contractions. A necessary step to avoid plugging of the tube with food particles during aspiration is to place the patient on a clear liquid diet for at least twelve hours before the test in a patient preoperatively and thirty-six to forty-eight hours, if possible, in a patient postoperatively. Samples are collected at ten minute intervals and placed in separate specimen bottles, and the character and color of the secretion are recorded. The volume of each sample is measured, and the free acidity is titrated with the use of Toeffer's reagent as an indicator. Samples heavily stained with bile must be properly evaluated when the results of the test are being interpreted. Contamination of the samples with saliva is minimized by instructing the patient to expectorate during the test and not to swallow any of his salivary secretion. After the first ten minute sample, a blood specimen is drawn for glucose determination, and 20 units of crystalline insulin is injected intravenously. The test is continued until a definite secretory response is observed, or for a period of ninety minutes following the injection of the insulin. The patient is carefully observed, and the symptoms of hypoglycemia are recorded. These occur in thirty-five to sixty minutes and may be very mild and transient or marked, although in our whole series of over 500 patients, most of whom have had two or more insulin tests, we have never had any untoward sequelae from the procedure. Only in patients with suspected coronary disease do we hesitate to use the test. We have never observed the occurrence of a gastric secretory response in the absence of hypoglycemic symptoms, although the reverse is occasionally true, even in the nonvagotomized subject. One hour after the injection of insulin, another blood sample is drawn for glucose determination. In choosing one hour as the interval, we were influenced by observations on a series of 87 patients at the Illinois State Penitentiary, on whom blood sugar determinations were done at thirty minute intervals for one and a half hours following the intravenous injection of 20 units of crystalline insulin. Glucose determinations were done on finger tip blood by the micro method of Folin and Malmros. This method gives figures that are somewhat high. The average fasting blood glucose level in this group of patients was 95.5 mg. per hundred cubic centimeters. Thirty minutes after the intravenous injection of insulin, the average blood glucose level was 49.0 mg., at sixty minutes it was 50.7 mg., and

at ninety minutes it was 53.6 mg. per hundred cubic centimeters. We feel that one hour allows sufficient time for the blood sugar to fall to its lowest point in the more resistant subjects, and in the patients with a more labile response the level has not begun to rise significantly at the end of a one hour interval. In an attempt to evaluate the necessary degree of hypoglycemia to produce a gastric secretory response, a careful analysis was made of fifty insulin tests in which a definite gastric secretory response was obtained. These are shown graphically in figure 3. Blood sugar levels were determined before and one hour after injection of

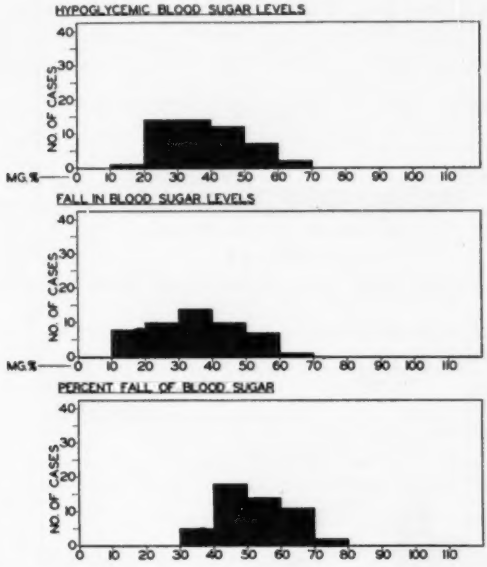

Fig. 3.—Observations on hypoglycemia in a series of 50 insulin tests which gave a positive reaction.

20 units of crystalline insulin intravenously, as described. They were determined photoelectrically, with the use of the Folin-Wu color reaction on the Shaffer-Hartmann filtrate. Inspection of the chart reveals considerable variation in both the degree of hypoglycemia and the actual fall in blood sugar, although the percentage fall shows a little more consistency. On the whole, we feel that the appearance of clinical signs and symptoms of hypoglycemia is probably a more constant and reliable criterion than the blood sugar level. The gastric secretory response occurs coincidentally with the hypoglycemic symptoms. In the presence of this response the test reveals vagal innervation to the stomach. Rarely,

for no known reason, with adequate lowering of the blood sugar and marked symptoms of hypoglycemia the secretory response is absent even in the presence of intact vagi. In all cases in which this has been encountered, repeated testing has resulted in a positive response. Occasionally the response is somewhat delayed, occurring fifteen or twenty minutes after the onset of hypoglycemic symptoms. In the

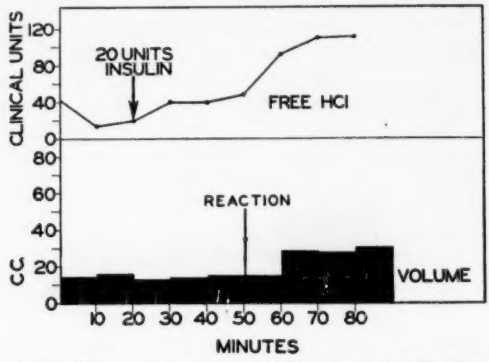

Fig. 4.—Positive gastric secretory response to insulin hypoglycemia.

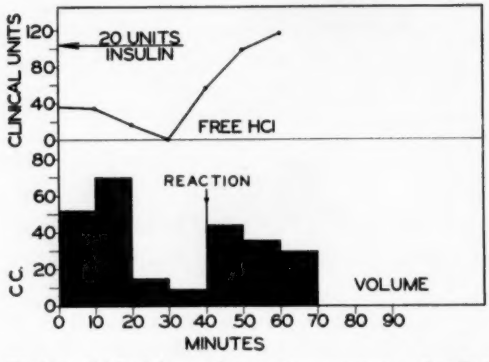

Fig. 5.—Positive (biphasic) gastric secretory response to insulin hypoglycemia.

normal reaction to the insulin test there is an increase in the volume and free acidity of the gastric juice (fig. 4). In almost half (42 per cent) of the tests there is observed a period of inhibition of secretion in which both the volume and the acidity of the aspirated gastric juice are much reduced (fig. 5). This period of inhibition occurs just before the onset of hypoglycemic symptoms. Its cause and mechanism are unknown. It seems to be unrelated to vagus function and as it is observed after vagotomy

(fig. 6). Even when the initial secretory level is high, the inhibitory phase may be observed followed by the normal secretory response (fig. 5). Occasionally there is no change in acid concentration, but a large volume of gastric juice is secreted during hypoglycemia. If reflux of intestinal content and technical errors in aspiration can be ruled out, this constitutes a positive response. A negative reaction to the test is characterized by the absence of the secretory increase coincident with the hypoglycemic symptoms. The secretory rate may stay the same or show a steady decrease or considerable inhibition. Indeterminate reactions are those in which there is continuous secretion at so high a level that any response would be obscured, and these are seen only preoperatively. Likewise, if there is no free acid in any sample, it is difficult sometimes to be sure that the test is valid, as the tube may

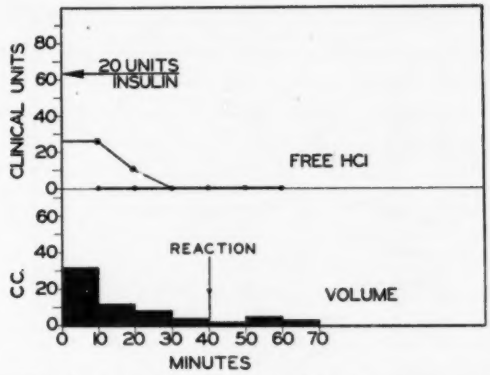

Fig. 6.—Negative reaction to insulin test following vagotomy, showing persistence of inhibitory phase.

have been displaced into the duodenum or jejunum or the samples may be contaminated by reflux of intestinal content. If these factors can be ruled out, such a reaction may be safely considered negative.

In view of the numerous complicating factors involved and the all-or-none (qualitative) nature of the test, we cannot set up arbitrary criteria for a positive response. Our own feeling, based on considerable experience, is that any reaction which raises doubt in the mind of the clinician who is attempting to evaluate it is probably positive and will prove so on subsequent testing.

The gastric secretory response to sham feeding is much less clear-cut than the response to insulin hypoglycemia, but it is nevertheless a useful confirmatory measure. When the insulin test is believed to be contraindicated, as in coronary disease, the sham meal may be used as

a substitute. The technic of collecting samples is the same as in the insulin test and is subject to the same difficulties. Three or four fasting ten minute samples are secured, and then the patient is presented with a light breakfast of his own choice, which he masticates and expectorates completely. Great care must be used to have the manner of presentation of the food as pleasant and appetizing as possible. The expectorated food must be disposed of rapidly and the container kept covered as much of the time as possible to avoid producing a feeling of disgust in the patient which results in a psychic inhibition of secretion. Unfortunately, it is almost impossible for most patients to avoid swallowing a little food and saliva, which results in partial neutralization of the gastric content as well as difficulty with aspiration of food particles. In our experience, only those who chew tobacco were able to undergo perfectly

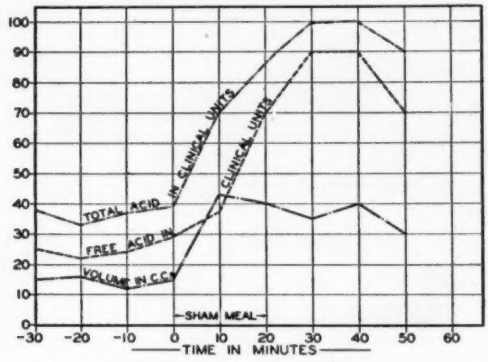

Fig. 7.—Typical gastric secretory response to sham feeding.

satisfactory sham meal tests. The period of mastication is allowed to continue for ten minutes, and samples are collected for the succeeding forty minutes. A positive response consists of a definite increase of secretion during the two samples following the termination of the meal (fig. 7). An increase in secretion occurring later than this is considered probably to be due to hormonal stimulation resulting from swallowed food particles. A comparison of the efficiency of the sham meal and the insulin test as a means of stimulating vagal gastric secretion is shown in table 5. It is obvious that insulin hypoglycemia is a much more efficient stimulus of gastric secretion than sham feeding and hence provides a more standard and reliable method of physiologic testing.

In reviewing the results of these various secretion studies in patients after vagotomy, it is apparent that between 10 and 15 per cent still have evidence of vagal pathways to the stomach. We consider these patients

to have undergone incomplete vagotomy. This incidence is proportionately the same in patients operated on transthoracically or by the transabdominal route. In a patient who shows a positive gastric secretory response with the onset of insulin-induced hypoglycemia, there seems

TABLE 5.—*Gastric Secretory Response*

Insulin Hypoglycemia		Sham Feeding
107 (100%)	Total Cases	45 (100%)
98 (92%)	Positive response	34 (76%)
1 (1%)	Indeterminate	1 (2%)
8 (7%)	Negative	9 (25%)
102 (90%)	Positive on repeated testing	36 (80%)

TABLE 6.—*Patients with Positive Reactions to Postoperative Insulin Tests After Incomplete Vagotomy* *

Number of Patient	Date of Operation	Operation	Reduction of Hydrochloric Acid Output, %	Symptoms of Stasis	Clinical Results
11	5/24/44	Transthoracic vagotomy	27	0	Excellent
17	11/24/44	Transthoracic vagotomy	66	0	Excellent
22	12/27/44	Transthoracic vagotomy	None	++	Recurrence
28	1/19/45	Subdiaphragmatic vagotomy and posterior gastroenterostomy	45	0	Excellent
29	1/19/45	Subdiaphragmatic vagotomy and posterior gastroenterostomy	61	0	Recurrence
40	8/24/45	Subdiaphragmatic vagotomy	14	+	Recurrence
42	9/10/45	Transthoracic vagotomy	None	+++	Recurrence
46	11/ 7/45	Subdiaphragmatic vagotomy and posterior gastroenterostomy	None	0	Excellent
58	2/15/46	Subdiaphragmatic vagotomy and posterior gastroenterostomy	22	0	Excellent
59	2/27/46	Transthoracic vagotomy	..	++	Excellent
86	6/17/46	Subdiaphragmatic vagotomy and posterior gastroenterostomy	..	0	Excellent
88	6/24/46	Subdiaphragmatic vagotomy and posterior gastroenterostomy	..	0	Excellent
95	7/16/46	Subdiaphragmatic vagotomy and posterior gastroenterostomy	..	0	Excellent
116	9/24/46	Subdiaphragmatic vagotomy	57	0	Excellent
119	10/ 4/46	Subdiaphragmatic vagotomy and posterior gastroenterostomy	..	0	Excellent
124	10/18/46	Subdiaphragmatic vagotomy	None	0	Recurrence
X-2	10/17/46	Subdiaphragmatic vagotomy	..	++++	Excellent
X-10	12/ 5/46	Subdiaphragmatic vagotomy	..	0	Excellent

* The diagnosis for patient 17 was jejunal ulcer. For all others it was duodenal ulcer.

little doubt that vagal innervation to the stomach persists. Consequently, we have used this criterion as our primary method of classification. In one series of 70 patients with duodenal ulcer treated by simple vagotomy, 10, or 14 per cent, had a positive insulin response after vagotomy. Correlation of the night secretion data with a positive postoperative insulin test in this group is shown in figure 1. Patients with

positive postoperative responses to the insulin test are designated in the crosshatched areas. In general, these patients have persistently high nocturnal gastric secretion postoperatively. Figure 6 shows that no patient with greater than 60 per cent reduction in his twelve hour night gastric secretion had a positive postoperative response to insulin. Conversely, of 18 patients who had less than 60 per cent reduction in the twelve hour night secretion, only 8 gave a negative response to the test. There is a small group of patients, who although they have persistently negative reactions to insulin tests, maintain a continued high night secretion. Three patients in this series of 70 demonstrated this phenomenon. Whether or not these patients have persistent vagal innervation to the stomach is a matter which is not as yet entirely clear. Among 160 consecutive patients treated by vagotomy 18 were found to have undergone incomplete vagotomy as defined previously. The clinical course of these 18 patients is summarized in table 6. One third of these patients have had persistence or recurrence of peptic ulcer.

EXPERIMENTS ON ANIMALS

Quantitative studies of the effect of vagotomy on the total secretion of gastric juice both in the fasting stomach and after the stimulus of food taking are almost necessarily inaccurate in man. The difficulties in collection led to the development in this laboratory of water-tight gastric fistulas which make possible quantitative collections of gastric juice from Pavlov or Heidenhain pouches or from the totally isolated stomach in animals for periods of many months. The production of the totally isolated stomach with preservation of its vagal innervation and blood supply was first described by Dragstedt and Ellis [8] in 1929, and the various modifications in the procedure in use in this laboratory at the present time are described in a recent publication.[9] This method lends itself admirably to a quantitative study of the effect of vagotomy since the total secretion of gastric juice by the isolated stomach may be collected for long periods before and after division of the vagus nerves to the stomach. The response of the stomach to insulin hypoglycemia makes it possible to check the functional capacity of the secretory fibers in the vagi before vagotomy and the completeness of this operation afterward.

Seventeen dogs were prepared with total isolation of the stomach as indicated in figure 8. After recovery from the operation, the gastric juice was collected in a rubber football bladder attached to the gold-plated brass or nylon plastic cannula. Each day the bag was emptied, the dog was given an intravenous infusion of Ringer's solution amounting to 100 to 200 cc. more than the previous twenty-four volume

8. Dragstedt, L. R., and Ellis, J. C.: Am. J. Physiol. **93**:407, 1930.

9. Dragstedt, L. R.; Woodward, E. R.; Neal, W. B., Jr.; Harper, P. V., Jr., and Storer, E. H., Arch. Surg., to be published.

of gastric juice and the animal fed a standard diet of milk, sugar, horse-meat, hamburger, bone meal and brewer's yeast. Free acidity of the twenty-four specimen was determined by titrating with one-tenth normal sodium hydroxide, Toeffer's reagent being used as an indicator. Peptic power was determined by a method described by LeVeen.[10] A 1:250 dilution of gastric juice in 0.05 normal hydrochloric acid is incubated with a standard solution of egg albumin. The remaining albumin is precipitated with sulfosalicylic acid and determined nephelometrically on the Evelyn colorimeter.

Vagotomy was performed in 12 of the 17 animals, by the trans-thoracic route in 11 and transabdominally in 1. The figures for the twenty-four gastric secretion before and after vagotomy are summarized in table 7. In every case there was a profound reduction in the volume,

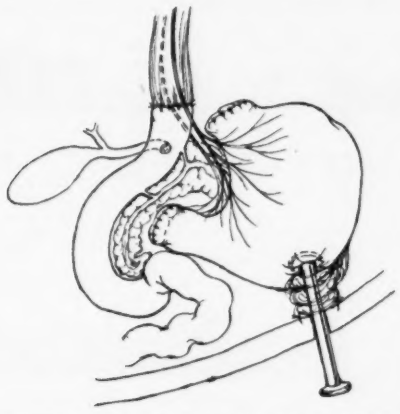

Fig. 8.—Diagram of the vagally innervated, totally isolated stomach in the dog.

free acidity and hydrochloric acid content of the twenty-four hour secretion as a result of the vagotomy. Table 8 shows the per cent reduction of the twenty-four hour secretion. The decrease in volume varied from 37 to 78 per cent, averaging 56 per cent. The decrease in free acidity of the twenty-four hour secretion varied from 18 to 82 per cent, averaging 49 per cent. The reduction in the twenty-four hour hydrochloric acid output varied from 46 to 92 per cent, averaging 76 per cent. This compares closely with the reduction obtained by vagotomy in the patient with duodenal ulcer. In 11 of the 12 animals, vagotomy produced a moderate decrease in the peptic power of the gastric juice. This reduction varied from 11 to 72 per cent, averaging

10. LeVeen, H. H.: Proc. Soc. Exper. Biol. & Med. **63**:257, 1946.

TABLE 7.—*Effect of Vagotomy on Gastric Secretion in Total Pouch Dogs*

	Before Vagotomy					After Vagotomy					
Dog No.	Number of 24 Hour Collections	Average Volume, Cc.	Average Free Acid, Clinical Units	Average Hydrochloric Acid Output, mEq.	Average Peptic Power, Units	Number of 24 Hour Collections	Average Volume, Cc.	Average Free Acid, Clinical Units	Average Hydrochloric Acid Output, mEq.	Average Peptic Power, Units	Comments
D-802	19	1084	..	....	..	5	239	..	...	..	Died of perforated ulcer on 6th day after vagotomy
D-804	4	491	..	....	..	..	...	..	...	..	Died of perforated ulcer on 7th day
D-806	25	451	53	23.8	87	13	106	18	1.9	66	
D-812	10	802	72	58	84	16	355	17	6	59	
D-814	0	...	..	....	..	..	...	..	...	..	Died of perforated ulcer on 4th day
D-835	37	261	28	7.3	..	..	...	..	...	..	Persistently negative reaction to insulin test; vagi intact at autopsy
D-839	21	662	51	34	43	5	265	17	4.5	63	
D-861	7	604	35	21.1	80	2	243	16	3.9	43	
D-865	10	903	101	92	68	51	546	73	40	48	
D-875	17	756	109	92	88	35	358	59	21	25	
D-898	25	415	49	20	76	13	241	9	2	53	
D-912	30	331	71	24	88	43	210	61	13	78	
D-954	46	465	107	50.8	85	87	251	88	22.7	57	
D-962	87	441	100	44.1	88	230	111	57	8.3	68	Still living
D-979	33	834	105	87.6	104	..	...	..	...	..	Died in 6 weeks due to chronic hemorrhage from ulcer
D-996	45	624	94	58.7	..	39	304	50	15.2	..	Died of inanition; chronic ulcer in pouch
D-16	24	687	72	49.5	..	..	...	..	...	..	Died in 5 weeks due to chronic hemorrhage from ulcer

TABLE 8.—*Per Cent Reduction in Average Twenty-Four Hour Gastric Secretion Following Vagotomy in Total Pouch Dogs*

Dog Number	Volume, Percentage	Free Acid, Percentage	Hydrochloric Acid Output, Percentage	Power, Percentage
D-802	78	..	..	..
D-806	77	66	92	24
D-812	56	76	90	30
D-839	60	67	87	47% increase
D-861	60	54	85	40
D-865	40	28	57	29
D-875	53	46	74	72
D-898	42	82	90	30
D-912	37	14	46	11
D-954	46	18	55	33
D-962	75	43	81	23
D-996	51	47	74	..
Average reduction	56	49	76	32

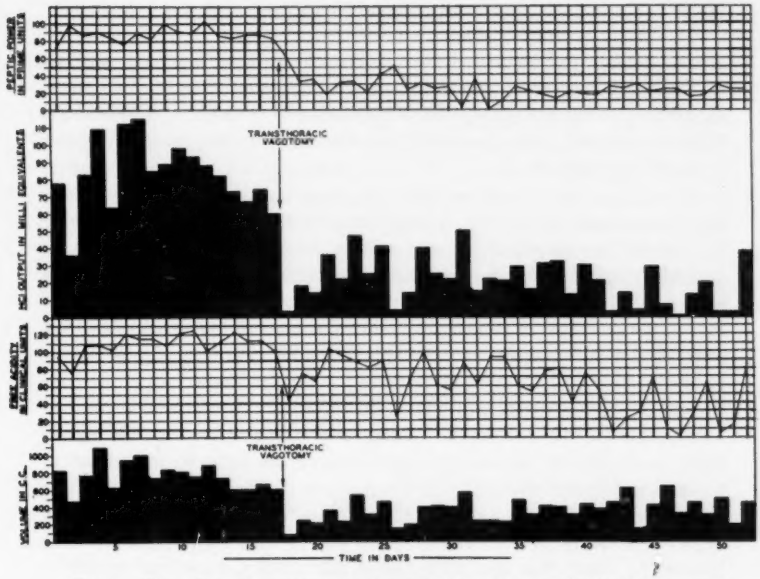

Fig. 9.—The effect of vagotomy on the secretion of the totally isolated stomach of dog 875. Daily twenty-four hour secretion.

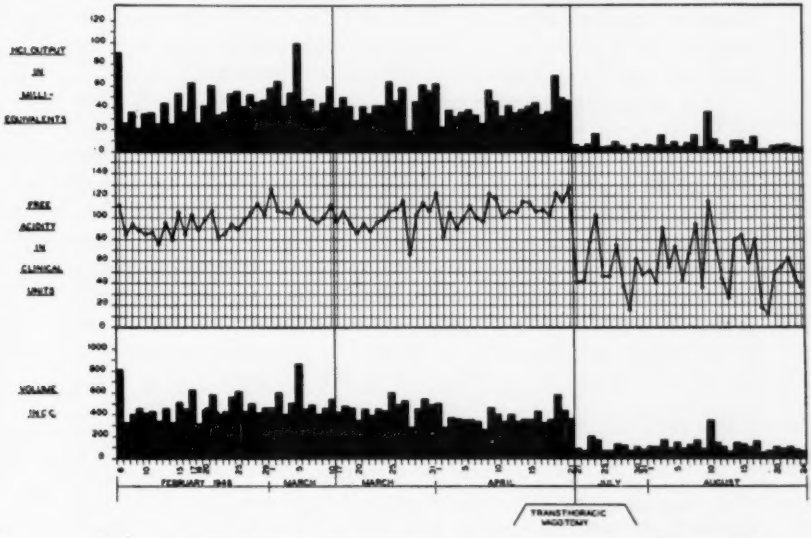

Fig. 10.—The effect of vagotomy on the secretion of the totally isolated stomach of dog 962. Daily twenty-four hour secretion.

32 per cent. In 1 animal, however, there was a 47 per cent increase in the peptic power of the gastric juice. Figures 9 and 10 illustrate in graphic form the change in the volume, free acidity, hydrochloric acid output and peptic power of the twenty-four hour daily secretion in 2 of these animals.

In each animal the integrity of the vagus innervation to the gastric pouch was established prior to vagotomy by the use of the insulin test. Essentially the same technic was used as in patients with peptic ulcer, with the exception that 5 or 10 units of insulin is adequate. In animals with a totally isolated stomach there is usually a pronounced augmentation in the secretion of gastric juice with the onset of hypoglycemia. Not only do the volume and free acidity rise, but also the peptic power of the gastric juice increases markedly. This increase in pepsin concentration, characteristic of "vagus juice," is as diagnostic of a positive response as is the increase in volume and free acidity. In the human being, however, an increase in peptic power has been so inconstant as to be of no diagnostic aid in interpretation of insulin response. In 1 dog (D-835, table 7) the response to insulin hypoglycemia remained negative, although at autopsy the vagus nerves were grossly intact. It is interesting that this animal's twenty-four hour secretion remained extremely low. After vagotomy, at least two negative responses to insulin hypoglycemia were obtained in each test animal.

The quantitative response of these animals to a standard dose of histamine was reported by Oberhelman and Dragstedt [11] to be markedly reduced. This reduction in hydrochloric acid output varied from 61 to 77 per cent, averaging 69 per cent in the 4 animals tested.

In 2 animals the effect of partial vagotomy was studied. In 1 the left vagus nerve was crushed in the neck, and, as seen in figure 11, the twenty-four hour secretion of gastric juice continued undiminished, although the peptic power of the juice was slightly reduced. The animal still responded to insulin hypoglycemia in the same fashion as before unilateral cervical vagotomy. After complete transthoracic vagotomy, there was a profound reduction in the volume and acidity of gastric secretion, and the reaction to the insulin test became negative. In the second animal the right vagus nerve was crushed in the cervical region, and in this animal also there was no decrease in the volume or acidity of the twenty-four gastric secretion. The animal still responded to insulin hypoglycemia. Again after complete transthoracic vagotomy, there was a marked decrease in gastric secretion and the reaction to the insulin test became negative.

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11. Oberhelman, H. A., Jr., and Dragstedt, L. R.: Proc. Soc. Exper. Biol. & Med. **67**:336, 1948.

Four animals succumbed to peptic ulcer in the early postoperative period, 2 from perforation and 2 from hemorrhage. In each case autopsy revealed a typical, large, penetrating, chronic peptic ulcer. In 1 animal (D-861) bloody gastric juice indicated the presence of an ulcer. Transthoracic vagotomy was performed, but the animal died of a perforation five days later. In another animal (D-996) transthoracic vagotomy was performed in similar circumstances. Bleeding markedly diminished, and the juice eventually became relatively clear. However, the animal succumbed to inanition six weeks later, and autopsy revealed a large, healing ulcer with the base extensively filled in with scar tissue.

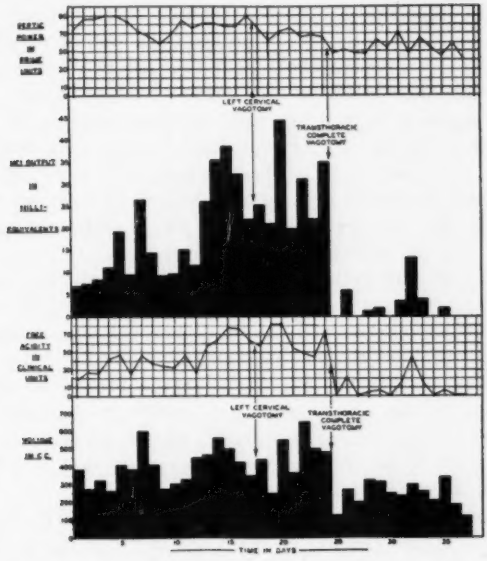

Fig. 11.—The effect of unilateral vagotomy on secretion of the totally isolated stomach of dog 898. Daily twenty-four hour secretion.

COMMENT

The regular occurrence of a continuous secretion of gastric juice in the intervals between meal taking in normal man may now be regarded as definitely established. This continuous secretion occurs at night during sleep and when the stomach has been completely emptied of food particles. It may be collected in large part by means of an accurately placed intranasal gastric tube combined with continuous suction. The volume of fluid obtained is of lessened significance since the specimens are often contaminated with swallowed saliva or regurgitated duodenal juices. If, however, measurements are made of the volume and the free

acid concentration, an estimation of the activity of the fundus glands may be obtained. The product of the two expressed as milliequivalents of hydrochloric acid represents the amount of acid secreted in the twelve hour period. It is probable that a measurement of the total chloride concentration would be more accurate since most of the chloride in the gastric content comes from the parietal cells. Normal adults were found to secrete an average of 18 milliequivalents of hydrochloric acid in the empty stomach at night when asleep and consequently shielded from the stimulus of food. Under the same conditions a series of 135 patients with duodenal ulcers secreted 60 milliequivalents, or almost four times as much. This excessive secretion is of neurogenic origin since in almost every instance it was reduced to considerably less than normal values by complete gastric vagotomy. In rare instances we have observed a persistence of hypersecretion in spite of what appeared to be a complete vagotomy, and these exceptional cases are the subject of further study. In a series of 70 patients the output of acid before operation was 55 milliequivalents, and this fell to an average of 11 milliequivalents after complete vagotomy. It thus appears that the continuous secretion in patients with duodenal ulcer is 80 per cent neurogenic in origin and 20 per cent dependent on other factors. The fact that the secretion of acid in these patients after vagotomy was less than that found in normal persons not operated on indicates that tonic secretory impulses over the vagus nerves play a large role in the continuous secretion of gastirc juice in normal man. It is a surprising phenomenon that this nervous secretion continues during deep sleep. The excessive activity in patients with ulcer is probably in some way dependent on the nervous and emotional tensions so common among them, and this problem should be extensively studied. If the excessive tonic secretory activity of the vagus nerves proves to be due to emotional tension, the night secretion of gastric juice might prove to be of value as an objective measurement of this mental process. Psychotherapy reported to be of value in patients with ulcer could then be checked by quantitative measurement.

Determination of whether or not all the vagus fibers to the stomach have been interrupted remains an important factor in the postoperative check-up of patients undergoing vagotomy for peptic ulcer. Three criteria for this purpose are employed in this clinic at the present time. The most important of these is reduction in the output of acid in the night secretion. Failure to secure a reduction of more than 60 per cent usually means that the vagotomy has been incomplete. Second in importance is failure to demonstrate an increased gastric secretion in response to adequate insulin-induced hypoglycemia. The intravenous injection of 20 units of regular insulin usually suffices to reduce the blood sugar to about half the normal level and to produce hypoglycemic

symptoms. In our experience there is a better correlation between the appearance and severity of these symptoms and the degree of gastric secretory stimulation than obtains with the actual depression in the blood sugar level. The test is by no means infallible, and occasionally no increase in gastric secretion may be obtained in normal persons even with pronounced hypoglycemia and accompanying symptoms. When the test is repeated, however, a positive response is always secured. A persistently negative response may be obtained during the first two or three weeks after vagotomy even though all the vagus fibers have not been severed. This is probably due to trauma to these nerves at the time of operation. Recovery of their ability to conduct impulses is evidenced by a positive response to insulin hypoglycemia six weeks later. This immediate recovery must be interpreted not as indicating the regeneration of severed nerves but rather as a sign that the operation was incomplete.

Gastric secretory response to a sham meal as a test for persistent vagus function is at present employed only in patients in whom the production of insulin hypoglycemia may be contraindicated and as confirmation of the insulin test in doubtful cases. A positive response may be considered significant, but a negative result is meaningless unless secured in at least three tests.

The experiments on animals afford a degree of precision that cannot be secured in clinical studies, and here the great importance of the vagus nerves in gastric secretion is evident. The preparation used is not strictly physiologic, however, since only the nervous and intestinal phases of secretion are present. The antrum is in the isolated stomach, is shielded from contact with food and accordingly does not contribute its share in the total secretory stimulus of the food. The preparation permits, however, of a comparison of the relative importance of the nervous and intestinal phases of gastric secretion. After complete vagotomy the total output of hydrochloric acid from the stomach was reduced an average of 76 per cent, the volume 56 per cent, the free acidity 49 per cent and the peptic power 32 per cent. Thus, if the output of hydrochloric acid be taken as an index of the secretory activity of the fundus glands, the nervous phase of gastric secretion is more important than the intestinal phase in the ratio of 3 to 1.

The negative effect of unilateral vagotomy on gastric secretion is graphically illustrated in figure 11. In this animal with a totally isolated stomach, division of the left vagus nerve in the neck had no effect on the volume, free acidity or total output of acid in the gastric juice. A slight but possibly significant decrease in the output of pepsin was produced. This finding suggests that the individual vagus fibers do not innervate individual secretory cells or glands but rather that some intermediate plexus is involved.

SUMMARY AND CONCLUSIONS

1. A continuous secretion of gastric juice occurs in normal persons when the upper part of the alimentary tract is empty of food and the subject is asleep or shielded from the sight, smell or taste of food. Under these conditions an average of 18 milliequivalents of hydrochloric acid is secreted during a twelve hour period at night.

2. Under the same conditions 135 patients with duodenal ulcers secreted an average of 60 milliequivalents of hydrochloric acid, or almost four times as much as the normal level.

3. The output of hydrochloric acid in patients with duodenal ulcer is reduced to an amount below the normal level by complete vagotomy, thus indicating that the hypersecretion in these patients is neurogenic in origin and also that the continuous secretion in normal man is partly due to a secretory tonus in the vagus nerves.

4. A determination of the amount of hydrochloric acid secreted by the empty stomach of patients with ulcer in a given period is the most important index of the secretory abnormality in these patients and is the best guide in evaluating the completeness of vagotomy and the most useful measurement in subsequent management.

5. An increase in gastric secretion in response to insulin hypoglycemia constitutes definite evidence that functional secretory fibers to the stomach are present. Failure to secure a response in normal persons is occasionally seen and not infrequently in the immediate postoperative period even when vagotomy has been incomplete. Repeated tests at subsequent periods elicit positive responses in these persons.

6. Repeated negative secretory response to insulin hypoglycemia is good evidence that vagotomy has been complete, and a reduction in acid output greater than 60 per cent is usually found.

7. An increase in gastric secretion in response to a sham meal indicates that functional secretory nerves in the vagi are present, but a single negative response is of less value as a criterion of complete vagotomy than is a negative response to insulin hypoglycemia.

8. In dogs with vagally innervated totally isolated stomachs, complete vagotomy reduces the output of hydrochloric acid by an average of 76 per cent. Since the nervous and intestinal phases of gastric secretion alone are operative in these animals, it is evident that the nervous phase is more important than the intestinal phase in the ratio of 3 to 1.

9. Section of one vagus nerve in the neck has no effect on the volume or acidity of secretion in dogs with vagally innervated isolated stomach preparations.

SIDE EFFECTS AND COMPLICATIONS OF SYMPATHECTOMY FOR HYPERTENSION

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THE LITERATURE contains reports of several thousand patients who have undergone various forms of sympathetic denervation for the relief of hypertensive vascular disease. A comparison of the various types of operative procedures employed has been made by us elsewhere.[1] In general, the majority of patients reported on have undergone resection of the sympathetic chain from the ninth thoracic through the second lumbar ganglion combined with bilateral resection of the splanchnic nerves. Although our operations, especially in the more severe cases, have recently tended to be more extensive, we have usually limited our resections to this extent. As our familiarity with this operation has grown, we have become aware of certain problems associated with it, which, while they are not of a magnitude to limit seriously the use of the operation, are of importance if the optimum results are to be obtained and if the procedure is to be kept from falling into disrepute. A careful study of operative complications is clearly indicated as an aid in evaluating the side effects and the risks of the operation and in pointing out the complications which are peculiar to the type of patient on whom it is performed. By this means morbidity and mortality rates can be reduced, and final results will be improved.

PHYSIOLOGIC CHANGES FOLLOWING SYMPATHECTOMY

Although certain changes in bodily physiology are an unavoidable result of sympathectomy, not infrequently if such effects have not been adequately explained preoperatively to the patient, these changes will be felt by him to represent complications of the surgical procedure rather than the anticipated result. Admittedly, from the patient's standpoint these alterations in his bodily functions may be disconcerting or even temporarily disabling, but they represent the price which he has

From the Department of Surgery, University of Illinois College of Medicine.

1. de Takats, G.; Julian, O. C., and Fowler, E. F.: The Surgical Treatment of Hypertension, Surgery **24**:469 (Sept.) 1948.

to pay for control of a disease which kills more persons than cancer each year.[2]

Postural Hypotension.—Among the side effects postural hypotension with its associated symptoms is the cause of most complaints. Whether or not postoperative postural hypotension is necessary to the achievement of a satisfactory reduction in blood pressure has not as yet been adequately determined though this would appear to be the case.[3] It is likely that patients in whom the vasospastic element constitutes the main cause of their hypertension will be the patients whose splanchnic and peripheral vascular bed will be most enlarged after removal of the sympathetic tone in these regions and hence who will have the greatest orthostatic hypotension. On the contrary, patients in whom the dilatation of the vascular bed is limited by the presence of organic disease, i. e., arteriolar sclerosis, will necessarily have a

TABLE 1.—*Relationship of the Severity of Hypertension to the Postural Hypotension Produced by Surgical Intervention*

Hypertensive Group	No. of Cases	Average Preoperative Blood Pressure	Average Postoperative Blood Pressure	Postural Hypotension	Result
Group I (mild)	17	158/96	136/87	76/41	Good
Group II (moderate)	24	207/128	176/110	103/58	Fair
Group III	10	234/158	210/153	None	All dead in 12 mo.

proportionately less significant postural hypotension. In our experience, unless a satisfactory postural fall in blood pressure is obtained, we have failed to perform an adequate sympathectomy or the patient was one of the group for whom sympathectomy was preoperatively considered to be of doubtful value but on whom operation was carried out as a last resort (case 1). We have found only slight reduction in the blood pressure after removal of the sympathetic vessels on one side, which is partially explained by the fact that the abdominal splanchnic pool in a large measure receives a bilateral sympathetic innervation which prevents notable enlargement of the vascular bed until bilateral denervation has been carried out and by the fact that unilateral denervation of an extremity is usually adequately compensated for by vasoconstriction of the remaining nondenervated portions of the body. However, after bilateral denervation in suitable cases, vasoconstriction in the nondenervated portions of the body is insuffi-

2. de Takats, G.; Heyer, H. E., and Keeton, R. W.: The Surgical Approach to Hypertension, J. A. M. A. **118**:501-506 (Feb. 14) 1942.

3. (*a*) Palmer, R. S.: Medical Evaluation of the Surgical Treatment of Essential Hypertension, J. A. M. A. **134**:9-15 (May 3) 1947. (*b*) de Takats, G., and Gilbert, N. L.: The Emergency Treatment of Apoplexy, ibid. **136**:659-665 (March 6) 1948.

cient to compensate for the vastly enlarged vascular bed, and postural hypotension is the end result. It is usual for a sympathectomized patient to demonstrate marked postural hypotension during the first few weeks or even months unless supportive measures are instituted. Even so, a patient whose blood pressure has been considerably reduced will at least be uncomfortable and will usually complain of fatigue, weakness and mental lassitude. A convalescence free of disabling hypotensive symptoms will be a rapid and relatively pleasant one, but, in general, this does not augur well for satisfactory long term results.

The temporary dizziness, faintness and lack of mental acuity present postoperatively in these patients is due primarily to a diminished circulating blood volume, although compensatory vasoconstriction of the cerebral vessels which further accentuates the cerebral anemia may represent a minor factor. That some degree of cerebral vasoconstriction can be present would appear to be demonstrated by the observation that procaine hydrochloride block of the appropriate stellate ganglion after cerebral thrombosis will often in a few minutes produce improvement in both motor and sensory paralysis and in psychic depression.[8b] This explanation is also suggested by cases with latent cerebral damage in which this damage has regained prominence after operation presumably because of diminished cerebral circulation (case 2).

Substernal Fluttering and Breathlessness.—A majority of patients will note a sensation of substernal fluttering or breathlessness early in their postoperative course, though not to a degree that might suggest anginal pain. The sensation of substernal fluttering is due to acceleration in the pulse rate in an attempt by the heart to compensate for the sudden fall in blood pressure, which is the result of decreased venous return to the heart. As is well known, postural hypotension and its associated unpleasant symptoms can be obviated to a large degree if the patient will assume the standing position only gradually or if he will avoid standing still once the erect position has been attained, since in both situations venous return is poor because of pooling of blood in a fully opened vascular bed. Wrapping of the lower extremities with elastic bandages and the use of elastic hose combined with an elastic girdle may occasionally be required for a period of weeks for severely incapacitated patients.[4] Before many weeks or months have elapsed, however, this notable degree of hypotension will disappear; some degree of postural hypotension may persist for years but not to the point at which it is uncomfortable.

Hyperhydrosis.—Hyperhydrosis of the nondenervated portions of the body may be discomforting for the patient. This, too, is most

4. Gambill, E. E.; Hines, E. A., and Adson, A. W.: The Effect of Certain Postures on Circulation Before and After Extensive Sympathectomies for Essential Hypertension, Proc. Staff Meet., Mayo Clin. **19**:271-278 (May 31) 1944.

severe during the immediate postoperative period and either gradually diminishes or loses significance in the eyes of the patient. Persistent, profuse, uncontrollable diaphoresis of the nondenervated areas has occurred most often among patients who underwent nearly maximal sympathectomies. Excessive sweating of the head and the upper extremities in such cases has at times produced an annoying and socially undesirable situation. Recently, a remote possible complication of extensive denervation relative to the problem of sweating has come to our attention in the case of a man who, after sympathectomy, repaired to a tropical climate, where he was apparently susceptible to heat exhaustion presumably because of the inadequacy of his heat-dissipating mechanism due to reduced sweating ability. A residual sweating area around the waist at the twelfth dorsal dermatome is often present without any scoring influence on results.

Accentuation of the Vasomotor Tonus.—Compensatory accentuation of the vasomotor tonus of the nondenervated portions of the body may be manifested by notable alterations in the vascular supply of the upper part of the trunk and the upper extremities. The observation of some patients subjected to sympathectomy will disclose cold, bluish white, mottled extremities, which will suggest the presence of cutis marmorata, acrocyanosis or even Raynaud's disease, though actually this is merely a manifestation of varying degrees of compensatory vasoconstriction in response to homeostatic demands. Case 5 is illustrative of such a response. Moreover, no severe trophic disturbances or actual gangrene can occur in the absence of previously demonstrable local vascular damage in the affected areas.

Derangement of Sexual Functions.—This is a matter of importance to the younger hypertensive men. Despite numerous references in the literature to the fact that the removal of the first and second lumbar ganglions bilaterally will produce loss of libido, failure of ejaculation and even sterility,[5] this has not been uniformly the case in our experience[6] or in that of others.[7] It seems probable that other factors are often involved when impotence does occur. Because of the importance of the psychologic element in influencing libido and potency, we have felt it unwise to emphasize this occasional undesirable sequel to sympathectomy by special reference to it in our postoperative follow-up

5. Simeone, F. A.: A Neuromuscular Mechanism in the Ductus Epididymidis and Its Impairment by Sympathetic Denervation, Am. J. Physiol. **103**:582-591 (March) 1933. Learmonth, J. R.: A Contribution to the Neurophysiology of the Urinary Bladder in Man, Brain **54**:147-176 (June) 1931.

6. de Takats, G., and Helfrich, L. S.: Sterility of the Male After Sympathectomy, J. A. M. A. **117**:20-21 (July 5) 1941.

7. Poppen, J. L., and Lemmon, C.: The Surgical Treatment of Hypertension, J. A. M. A. **134**:1-8 (May 3) 1947.

studies. Casual questioning or information volunteered by the patients has indicated no close correlation between the extent of denervation and sexual ability or libido. Erection has rarely been influenced; ejaculatory ability has more often been adversely affected. Sympathectomy has no adverse effect on the female genital tract since many records are available of women who, contrary to our advice, have become pregnant and have borne normal children. That an increase in blood supply to the reproductive organs may be at least a temporary result is suggested by 1 of our cases, in which a woman in whom menstruation had ceased a year prior to surgical intervention started to have regular periods in the absence of any demonstrable pelvic disease (case 4).

Motor or Sensory Dysfunction.—Motor or sensory dysfunction of a large portion of the intestinal tract might be anticipated as a result of its sympathetic denervation to a large degree. Postoperative abdominal discomfort and distention have not been rare in our experience, and it has been for this reason that we have avoided too rapid resumption of a general diet and have also felt it worth while to administer an ampule of neostigmine twice daily for the first few days. Distention and decreased intestinal motility is the reverse of what might be expected since the sympathetic supply to the bowel is largely inhibitory and the action of the now unopposed vagus is predominantly motor and secretory [8]; however, the degeneration of the residual preganglionic fibers might so stimulate the celiac ganglion cells that their postganglionic fibers might produce a transitory inhibitory effect on visceral motility. A subsequent increase in gastric motility and secretion might cause the development or recurrence of gastric or duodenal ulcers. This would appear to be a distinct possibility since autonomic instability is common to both the hypertensive person and the patient prone to suffer from ulcers. We have not noted this complication in our cases possibly because the concomitant alteration in visceral sensation may have masked the symptoms. Belgen and Kinter have reported cases in which there was aggravation of ulcer symptoms after sympathectomy,[9] and one of us (E. F. F.) has encountered a patient with reactivation of a previously healed ulcer as demonstrated by severe hemorrhage and enlargement of the ulcer crater, though in the absence of visceral pain, following sympathetic denervation. The recent work of Dennis, who has been employing vagotomy successfully in the alleviation of symptoms of ulcerative colitis, would by inference suggest that severe diarrhea or even ulceration of the bowel might be the occasional result

8. White, J. C., and Smithwick, R.: The Autonomic Nervous System, ed. 2, New York, The Macmillan Company, 1946, p. 137.

9. Belgen, H. M., and Kintner, A. R.: Aggravation of Gastric Ulcer Following Dorsolumbar Sympathectomy, J. A. M. A. **133**:1207-1208 (April 19) 1947.

of extensive sympathetic denervation, although this complication has not been reported. In fact, a spastic type of constipation seems to prevail.

Elimination of Visceral Pain.—Elimination of the sensation of visceral pain by sympathetic and splanchnic denervation has recently received much attention.[10] It has been known for years that gastric, renal, biliary and pancreatic pain as well as muscular rigidity of the abdominal wall due to reflex visceral action can be alleviated by sympathetic blocks of the seventh dorsal through the second lumbar segment and the selective blocking of definite levels has been utilized for differential diagnostic purposes.[11] Operations on the sympathetic nervous system directed toward the relief of intractable abdominal pain have been shown to be effective and are clearly indicated when further surgical intervention is contraindicated. However, the very success of these procedures serves to point out another possible complication inherent in sympathectomy for hypertension. Surgical removal of the visceral sympathetic nerve supply may so modify or abolish normal visceral sensation that the presence of ulcer or its complications, the acute manifestations of gallbladder, renal or pancreatic disease or, equally important, the development of malignant disease may be completely masked or misinterpreted until its late stages, when involvement of somatic nerves or systemic manifestations become evident. Time and careful postoperative observation of patients subjected to sympathectomy will determine whether or not these considerations are more theoretic than actual.

THE IMPORTANCE OF PROPER SELECTION OF CASES

Since not all cases of hypertension are amenable to surgical treatment, proper selection becomes a matter of vital importance if satisfactory results are to be obtained in a high percentage of cases and the incidence of complications is to be kept at a minimum. Our indications for surgical intervention have been discussed elsewhere,[12] but in brief they are based on the exclusion of patients whose hypertension is

10. Bronson, R. S., and Neill, C. L.: Abdominal Visceral Sensation in Man, Ann. Surg. **126**:709-724 (Nov.) 1947. Grimson, K. S.; Hesser, F. H., and Kitchin, W. W.: Early Results of Transabdominal Coeliac and Superior Mesenteric Ganglionectomy, Vagotomy, or Transthoracic Splanchnicectomy in Patients with Chronic Abdominal Visceral Pain, Surgery **22**:230-239 (Aug.) 1947. de Takats. G., and Walter, L. E.: The Treatment of Pancreatic Pain by Splanchnic Nerve Section, Surg., Gynec & Obst. **85**:742-746 (Dec.) 1947.

11. de Takats, G.: Local Anesthesia, Philadelphia, W. B. Saunders Company, 1928.

12. de Takats, G.; Fowler, E. F.; Graupner, G. W., and Jensik, R. J.: The Surgical Approach to Hypertension: Second Report, Arch. Surg. **53**:111-163 (Aug.) 1946. de Takats, G., and Fowler, E. F.: The Surgical Treatment of Hypertension: III. The Neurogenic Versus Renal Hypertension from the Standpoint of Operability, Surgery **21**:773-799 (June) 1947.

attributable to renal disease such as polycystic kidney, hypoplastic kidney, urinary obstruction and acute nephritis. However, nephrosclerosis and hypertensive vascular disease may persist after elimination of unilateral renal disease by means of nephrectomy, and in such instances section of the splanchnic nerves has given us spectacular results. Other contraindications are conditions in which hypertension is a manifestation of endocrine imbalance, of which the commonest examples are hyperthyroidism, menopausal syndrome, adrenal tumor and pleuriglandular syndromes of pituitary origin; situations in which disease of the central nervous system is fundamental, i. e., conditions producing increased intracranial pressure and psychic conditions or neurogenic syndromes not mediated through the splanchnic nerves, and finally vascular lesions of congenital origin, of which coarctation of the aorta is representative, or of acquired origin such as cardiac failure from whatever cause or arteriosclerosis in which a rigid aorta combined with arteriolar sclerosis produces a picture of hypertension but not one which we feel is benefited by sympathectomy. The remaining cases of hypertension of the so-called essential type we have divided into three groups for purposes of analysis of operative results. Of these, we have been of the opinion that only groups I and II can be definitely said to be benefited by sympathectomy. We have not felt that the history of cerebral vascular accidents, coronary occlusion or moderately diminished renal function as evidenced by slight elevation of the blood nonprotein nitrogen level need necessarily constitute an absolute contraindication to surgical intervention since not a few of the patients with these conditions may receive benefit from sympathectomy, though such incidents will to some extent influence our selection of cases. Reluctantly we have operated on some patients in group III despite the poor prognosis which is offered with or without surgical treatment, but our results have as a rule borne out our gloomy attitude. We are aware that this is not the approach or the attitude of all workers in this field,[13] but we believe that our conservative attitude is responsible for our lower morbidity and mortality rates.

THE COMPLICATIONS OF SECTION OF THE SPLANCHNIC NERVES PER SE

A hypertensive patient is not normal, and since this is so, it is natural that there should be certain complications peculiar to or more frequently encountered in the surgical care of such patients. In cases

13. Smithwick, R. H.: The Surgical Treatment of Hypertension, Arch. Surg. **49**:180-193 (Sept.) 1944. Peet, M. M.; Woods, W. W., and Braden, S.: The Surgical Treatment for Hypertension: Results in Three Hundred and Fifty Consecutive Cases Treated by Bilateral Supradiaphragmatic Splanchnicectomy and Lower Dorsal Sympathetic Ganglionectomy, J. A. M. A. **115**:1875-1878 (Nov. 30) 1940.

of hypertension, particularly those of the most severe type, cardiac, cerebral or renal complications are prone to develop as a direct result of sudden lowering of the blood pressure to an unaccustomed level. Preliminary evaluation in such cases may have demonstrated varying degrees of damage to these systems due to prolonged exposure to elevated intravascular pressure, and this may be made clinically evident or, if already clinically evident, accentuated by the newly acquired level of blood pressure.

Cardiac Complications.—Although it has been recognized for several years that patients with hypertension subjected to sympathectomy usually obtain notable subjective relief from previous cardiac complaints and that objective improvement as evidenced by electrocardiographic changes and diminution of the size of the heart is frequent,[14] this is not uniformly the situation. The improvements which are noted are due to a lightening of the cardiac load which follows the decrease in the peripheral resistance of the now dilated vascular bed. This is not only desirable but is usually essential to a satisfactory operative result. Still, early in the postoperative period a rapid shifting of the circulating blood volume may so diminish venous return that cardiac failure may be precipitated unless adequate care is rapidly instituted. Case 2 will serve to illustrate this point. If the circulatory system is supported during this critical period, a later satisfactory adjustment of the heart to its new working conditions will gradually occur unless actual chronic coronary insufficiency has been produced. It is also conceivable that a temporary reduction in coronary blood flow combined with changes in blood coagulability in the postoperative period might predispose to the production of coronary thrombosis. This is a supposition, however, which is difficult to prove clinically since the subjection of a patient with an already damaged vascular system to operation is in itself hazardous because the cardiac load is thereby increased appreciably if only for a short period. Case 3, in which operation was performed on another service, serves as a possible illustration of a death due to coronary thrombosis precipitated by the load of operation or the physiologic changes wrought thereby.

Cerebral Complications.—We have encountered several examples of disturbed cerebral function of a localizing nature following sympathectomy which would appear to be explicable on a basis of decreased cerebral blood flow due either to relative cerebral anoxia or to small foci of cerebral thrombosis precipitated by surgical intervention. Of interest is the fact that previously unnoted neurologic disorders have

14. Bridges, W. C.; Johnson, A. L.; Smithwick, R. H., and White, P. D.: Electrocardiography in Hypertension, J. A. M. A. **131**:1476-1480 (Aug. 31) 1946.

regained their former prominence for variable periods after operation. We have been fortunate in that these untoward manifestations have thus far been of a transitory nature though this might not always have been the case. Case 2 represents an example of this sort. Nonlocalizing manifestations of altered cerebral function such as psychic disturbances, usually mental depression or mental retardation, are not uncommon among the more severe cases of hypertension. We have had 1 case in which a definite psychosis developed postoperatively which was of extended duration.

Renal Complications.—Serious renal complications incident to surgical lowering of the blood pressure have not been notable in our series of over 250 cases, possibly because of our care in eliminating patients

TABLE 2.—*Surgical Complications of Sympathectomy for Hypertension in 100 Cases (i. e., 200 Operations)**

Complications	No. of Cases	Incidence, %	
A. Severe complications			
(1) Cardiac	6	3	7
(2) Neurologic	6	3	
(3) Renal	0	0	
(4) Shock	2	1	
B. Painful complications			
(1) Myalgia	10	5	13
(2) Neuralgia	16	8	
C. Pulmonary complications			
(1) Pneumothorax and atelectasis (on roentgenologic examination)	28	14	23
(2) Hydrothorax or hemothorax (on roentgenologic examination)	18	9	
D. Wound infection	4	2	

* The prolonged morbidity rate was below 10 per cent and the mortality rate below 1 per cent.

with severe renal damage. Still, it is theoretically possible that a situation might arise in which excessive lowering of the blood pressure might so diminish renal perfusion and glomerular filtration pressure that adequate excretion of waste products might be made impossible. This complication must be relatively infrequent even in kidneys damaged to the point where there is some increase of the nonprotein nitrogen level. A reduction in filtration pressure may even in some measure be compensated for by reduction in renal ischemia resulting from sympathetic denervation. Postoperative deaths due to uremia have, however, been reported by others,[15] exclusive of instances in which sympathectomy obviously failed to arrest progression of the hypertensive process.

15. Phelps, M. L., and Burdick, D. L.: Anesthetic Management of Patients Undergoing Sympathectomy for Hypertension, Anesthesiology **4**:361-371 (July) 1943.

THE TECHNICAL COMPLICATIONS OF SECTION OF THE SPLANCHNIC NERVES

If proper selection of cases has been employed, technical complications will account for most of the morbidity encountered after sympathectomy.

Shock.—Shock should be a rare occurrence in any planned surgical procedure if proper precautions are taken. Particularly in hypertensive persons, prolonged periods of hypotension are undesirable not only because of the ease with which patients go into profound shock but also because of the increased dangers of the effect of hypoxia on the already damaged cerebral and cardiac systems. We believe that performance of a bilateral sympathectomy and splanchnic resection at a single operation is an unnecessarily hazardous undertaking from the standpoint of shock since it is more time consuming, it necessitates readjustment of the position of the anesthetized patient which predisposes to a fall in the blood pressure and it produces a more rapid alteration in the circulating blood volume. Even in the two stage operation, particularly during and after the second stage, it is necessary to be on guard against acute hypotension. Utilization of fluids intravenously, preferably blood, and the intravenous or intramuscular administration of phenylephrine hydrochloride (neo-synephrine hydrochloride®) are routinely employed to maintain blood volume and blood pressure. On the patient's return from surgery, 18 inch (45.7 cm.) shock blocks are placed beneath the foot of the bed to assist venous return and to minimize cerebral ischemia. If close observation in the postoperative period reveals shock to be present or imminent, in addition to the continued administration of fluids intravenously, oxygen is administered, elastic bandages are applied to the extremities and a snug abdominal binder is used to prevent hypoxia and to support blood volume (case 2). Control of pain is essential to the patient's comfort and will also militate against shock.

Pulmonary Complications.—Pulmonary complications are common and may be the result of certain technical errors or oversights. Preoperative freedom of the patient from respiratory infections and adequate oral hygiene require no emphasis. To reduce bronchial secretion, which hampers anesthesia and predisposes to subsequent atelectasis, we utilize 1/150 grain (0.4 mg.) of atropine or 1/200 grain (0.3 mg.) of scopolamine prior to anesthesia. Good anesthesia is of extreme importance both to the general condition of the patient and in the provision of conditions favorable to rapid operation.[16] In this connection, we have found induction with nitrous oxide followed by ether most satisfactory. The

16. Langston, H. T.: The Pathology of Chronic Hemothorax, Surgery **21**: 137 (Jan.) 1947.

technic of sympathectomy requires no elaboration, but we believe that there are definite advantages to be obtained from maintaining the pleura intact. The retropleural exposure and the identification of the sympathetic chain and the splanchnic nerves are not difficult, and if perforation of the pleura is avoided the immediate complications represented by a flapping mediastinum and by increased anesthetic difficulties are obviated and late complications such as pneumothorax, hemothorax or reactive hydrothorax are reduced. The pleura is most frequently damaged during one of the following steps: during subperiosteal removal of the rib, in cutting the rib at its costochondral junction anteriorly or at the costovertebral junction posteriorly, at which point the pleura is firmly adherent, or during pleural reflection from the thoracic wall if there has been a failure to reflect the endothoracic fascia with the pleura, the pleura alone being so fragile that it is impossible to maintain it intact. During section of the diaphragm, if the pleural reflection onto the diaphragm is not clearly visualized or if forcible retraction of the lung is attempted before the pleura has been well separated from the thoracic wall, tension on the pleura may tear it or so distort the cleavage planes that a pneumothorax is produced. Occasionally the mediastinal reflection of the pleura may be mistaken for the splanchnic nerve momentarily, and in the attempt to pick this up with a sympathectomy hook a perforation may be produced. If previous pleuritis or mediastinitis has left its mark with dense adhesions, it may be difficult to avoid pleural perforation; if this occurs, all air and blood must be removed from the pleural cavity at the completion of the surgical procedure.[16a] Before the patient leaves the operating room physical examination and, if necessary, thoracocentesis should demonstrate the absence of pneumothorax and of a significant degree of atelectasis. Compression of the lung during the surgical procedure as well as pleural perforation predisposes to atelectasis on the side operated on, though equally often the other side will be discovered to be atelectatic because of mediastinal shift and the gravitation of secretions to this side. A thorough endotracheal toilet and adequate pulmonary aeration are largely the responsibility of the anesthetist and are an important one. However, the good work of the anesthetist must not be nullified by binders which limit expansion of the chest, undue depression of the cough reflex by unsuitable analgesic agents or failure to relieve pain so that the patient will be willing to cough or the unnecessary use of oxygen which will reduce the amplitude of respiration. On the positive side, the intermittent use of carbon dioxide inhalations may be of some aid in dislodging residual mucous plugs by provoking coughing. We believe that the prophylactic use of peni-

16a. At present, when entered, all pleural cavities are drained with mushroom catheters and continuous suction is used for forty-eight hours.

cillin is indicated not only for the control of infection in residual atelectatic areas but also for the huge area of dissection which has been contaminated to some degree. Should clinical findings or roentgenograms demonstrate any appreciable amount of air or fluid within the pleural cavity, aspiration affords the most rapid and satisfactory therapy;[17] however, unless one is familiar with the usual roentgenologic signs following sympathectomy, one may be easily misled as to the presence or location of the pathologic changes in the bizarre roentgenograms which are not infrequently seen.[17] The value of early ambulation has urged us to employ it as early as is consistent with the patient's safety, but because of the hypotensive effects of sympathectomy it is necessary to use some caution, the patient always being accompanied until he has gained some strength and has become familiar with his new limitations.

Neuralgia.—Neuralgia is a familiar complication and may be exceedingly troublesome. Intercostal neuralgia is most frequent and may be minimized if care is exercised not to damage the nerve while freeing the rib, retracting the intercostal bundle, severing the rib anteriorly or, especially, disarticulating the rib at its costovertebral joint posteriorly. It has seemed to us that neuralgia has resulted even when no obvious damage had been done to the nerves, and for this reason we have attempted various measures in the hope of its prevention. Resection of the nerve has been done both alone and together with resection of the posterior root ganglion, but this does not prevent pain from adjoining intercostal nerves and may produce an unsightly bulging anesthetic area in the abdominal musculature. Injection of procaine hydrochloride or alcohol into the nerve root has been uniformly successful. Genitofemoral or ilioinguinal neuralgia is less common and less severe and is usually encountered after definite injury to the nerves while the lumbar sympathetic ganglions are being exposed or identified. The treatment of neuralgia in our hands has been, in general, unsatisfactory, and in cases such as case 4 there exists the necessity for careful handling to avoid the real danger of drug addiction. Fortunately, within two to three months the neuralgia has disappeared.

Myalgia.—Myalgia of the sacrospinalis or psoas muscle groups is usually the result of injury produced while attempting to obtain satisfactory exposure of the lumbar sympathetic chain. It has seemed to us that cutting the former muscle actually has added little to the exposure and has been responsible at times for the presence of postoperative

17. Lord, J. W., Jr., and Hinton, J. W.: Operative and Postoperative Management of Hypertensive Patients Undergoing Thoracolumbar Sympathectomy, New England J. Med. **237**:840-843 (Dec. 4) 1947.

pain and weakness in the back. Injury to the psoas muscle is often the result of placement of the patient on the table which does not produce maximal relaxation of this muscle and thus demands the use of forcible and traumatic retraction. Management of the myalgia presents a problem similar to that mentioned in connection with neuralgia though fortunately the symptoms are usually somewhat less severe and less persistent.

Hemorrhage.—Hemorrhage from a major vessel has not been encountered in our series despite the proximity of the dissection to the large vessels. The vessels which we have found to be occasionally troublesome are the intercostal vessels when they are injured near the costovertebral junction high in the chest, the ascending lumbar veins and occasionally small phrenic vessels. Obviously, the problem is easily resolved by adequate exposure and by well controlled respirations combined with due caution. Generalized oozing from such an immense operative field is rarely a problem, but when present it may be a result of elevation of the blood pressure caused by straining, too rapid administration of fluids or, more often, accumulation of carbon dioxide. It has appeared that retropleural or incisional hematomas have been more frequent among our severely hypertensive patients. This might be in part explained by their elevated pressures, though we feel that the increased capillary fragility present in these patients may be a predisposing factor (case 5). For this reason we advocate the use of 50 mg of rutin four times a day as well as adequate doses of vitamin C preoperatively and postoperatively, since others have demonstrated,[18] and we have found in our experience, that rutin will definitely reduce capillary fragility and will provide further protection against cerebral vascular accidents.

Injury to the Thoracic Duct.—Injury to the thoracic duct in the course of sympathectomy has not occurred in our experience, though conceivably this duct might be mistaken for the major splanchnic nerve and sectioned if proper identification were not made. Should this occur, it would appear that ligation of the cut ends of the duct would be the wisest course.[19]

REPORT OF CASES

CASE 1 (previously reported in the ARCHIVES [12]).—B. H., a 21 year old married woman, entered the Research and Educational Hospital on Nov. 2, 1939, complaining of severe continuous headache, nausea, vomiting and severe pain in the chest lasting for two weeks.

18. Griffith, J. Q., Jr., and Lindauer, M. A.: Increased Capillary Fragility in Hypertension, Incidence, Complications and Treatment, Am. Heart J. **28**: 758-762 (Dec.) 1944.

19. Berry, W. H.: Traumatic Chylothorax, J. A. M. A. **133**:319-320 (Feb. 1) 1947. Meade, R. M. J.: Case Report, Chicago Surgical Society, January 2, 1948.

She was well up to the age of 17, when, four months after being married, she had a miscarriage. Her physician told her that she would never have a full term baby. A few months later she again became pregnant; she was told of her high blood pressure and the albumin in her urine. Her feet were swollen. Labor was induced, and she was unconscious for two days. A year later she had continuous headaches and then again became pregnant. She lost this baby around the third month. After this, nausea and vomiting were frequent. In April 1939 paralysis of the right facial nerve occurred, and in September 1939 paralysis in the left facial nerve developed. Severe knifelike pain appeared under the left costal margin. She did not know whether her pressure fell or not during this time.

On her entrance to the hospital both eyegrounds showed papilledema, exudates and hemorrhages. Her blood pressure varied from 250 to 210 systolic and from 150 to 136 diastolic millimeters of mercury. Neither thiopental sodium (pentothal sodium®) given intravenously nor sodium nitrate or amobarbital sodium (amytal sodium®) administered orally was able to depress the diastolic pressure below 140 mm. Administration of potassium thiocyanate was ineffective. Renal function was greatly impaired, the urea clearance being depressed to 15 cc. per minute, but with no nitrogenous retention. The urine showed red blood cells and casts, with 0.2 to 1.4 Gm. of albumin daily. The heart was enlarged, and the electrocardiogram showed evidence of myocardial damage.

Operations on January 2 and 23, 1940, consisted of bilateral supradiaphragmatic section of the splanchnic nerves. At her discharge from the hospital the blood pressure had reached its preoperative level. She died at home, suddenly, two months later.

Comment.—Our results in patients with post-toxemic hypertension have been favorable when the original vascular injury has not repeated itself. The patient should have been sterilized after her first miscarriage, since in the course of the succeeding four years three pregnancies produced malignant nephrosclerosis which was unresponsive to both medical and surgical management and terminated fatally. We have operated on a few such patients at the urgent request of the internists, but our experience has been that no type of operation will materially influence the outcome. This stage should, therefore, be regarded as a contraindication to operation.

Case 2.—A. T., a 46 year old white man, entered St. Luke's Hospital on April 14, 1947, complaining of hypertension of five years' duration which was discovered during a routine physical examination. Six months prior to his admission occipital headaches had developed but he had no other complaints.

On his entrance, examination revealed a blood pressure of 260 systolic and 155 diastolic. The heart was of normal size, the rate was 80 and the beat was of normal rhythm. The electrocardiogram showed the wave in lead I to be inverted and the T wave in lead II diphasic, and there was left axis deviation consistent with myocardial disease on the basis of damage to the coronary artery. Reactions to renal function tests were normal, there was no nitrogen retention and the intravenous pyelogram was normal. The basal metabolic rate was normal, but the Rumpel-Leede test showed twenty-five petechiae, and funduscopic examination showed advanced grade II angiospastic retinopathy. The blood pressure was still

labile, since by means of amobarbital sodium it could be reduced to 146 systolic and 100 diastolic.

Operation.—On April 23 sympathectomy from the ninth dorsal through the second lumbar ganglion, with resection of the splanchnic nerves, was done on the right side without production of pneumothorax, and a rental biopsy was performed, which showed group III renal hypertensive changes.

Postoperative Course.—On the day after the operation examination revealed atelectasis of the lower lobe of the right lung together with a small amount of fluid in the costophrenic angle, but this was rapidly corrected by carbon dioxide inhalations, which permitted the patient to cough up a large mucous plug, with subsequent complete aeration of the chest. The patient improved until five days later, when he became dyspneic, cyanotic and cold, and moist rales could be heard throughout the entire chest. The pulse rate rose to 125, and a gallop rhythm appeared. Clinically the patient exhibited pulmonary edema and left ventricular failure. An electrocardiogram taken at this time showed the T waves in leads I and II inverted and the T wave in lead III depressed as well as depression of the S-T segment in leads II and III, which was diagnosed as consistent with myocardial disease only. The patient was given oxygen, compression bandages were placed about the legs and he was given aminophylline. On the following day he was also given 2 cc. of a mercurial diuretic, and in the subsequent twenty-four hours he excreted 3,940 cc. of urnie. During the next four days the blood pressure became elevated from 90 systolic and 70 diastolic to 180 systolic and 100 diastolic, the pulse rate fell to 88 and a normal rhythm was established. The clinical signs of heart strain and pulmonary edema disappeared, and repeated electrocardiograms were similar to those taken on the patient's admission. He gradually improved so that by the twenty-third postoperative day he was able to walk several hundred yards without dyspnea. His electrocardiogram showed no further changes, and a roentgenogram of the chest showed only evidence of resorption of a small amount of blood or fluid from the right retropleural space. The patient was discharged to his home to recuperate before the second stage of the operation was attempted.

On June 22 the patient was readmitted. At this time his blood pressure was 230 systolic and 140 diastolic, his pulse rate was 80 and regular and the chest was normal clinically although roentgenograms still demonstrated a slight area of increased density just above the right side of the diaphragm. The blood was normal on chemical examination, and an electrocardiogram showed only those changes demonstrated during the original hypertensive study.

Operation.—On May 27 sympathectomy from the ninth dorsal through the second lumbar ganglion, with splanchnic resection, was done on the left side without the production of pneumothorax, and the patient left the operating room in good condition.

Postoperative Course.—The day after operation the patient had a blood pressure of 108 systolic and 70 diastolic, the pulse was regular, the respiratory rate was 24 and the chest was clear. He did, however, have definite facial paralysis on the left side. It is of interest in this connection that after operation on a mastoid at the age of 7 the patient noted facial paralysis, but this had improved to the extent that it had not been noted on preceding examinations. The following day his pulse rate mounted to 150, the respiratory rate increased to 36 and the patient became dyspneic. He also suffered from profuse diaphoresis of the nondenervated portions of the body. Clinical and roentgenologic examination of the chest at this time

showed no abnormalities. The blood pressure was still 110 systolic and 80 diastolic, but the radial pulse had become imperceptible though an electrocardiogram showed no change. Later spastic paraplegia developed on the right side, the head and eyes deviated toward the right and for a short period there was a loss of consciousness. The pallor of the patient suggested a profound alteration in the circulating blood volume as being responsible for the neurologic symptoms rather than a cerebral vascular accident. Treatment consisted in the administration of 0.3 cc. of phenylephrine hydrochloride (neosynephrine hydrochloride®) intravenously, 7½ grains (0.5 Gm.) of aminophylline intramuscularly every six hours, 3 cc. of adrenal cortical extract intramuscularly every six hours, 1½ grains (0.1 Gm.) of digifolin® (a digitalis preparation) twice daily, 500 cc. of blood and oxygen by mask. The blood pressure under this treatment gradually improved over the succeeding ten days, and all signs of paralysis rapidly disappeared. The patient did, however, acquire a severe and persistent hiccup which failed to respond to the ordinary forms of treatment and which after some sixty hours was finally controlled only by blocking the phrenic nerve with procaine hydrochloride. By July 10 the patient had sufficiently recovered to sit in a wheelchair for short periods, but postural hypotension and concomitant elevation of the pulse rate were so excessive that he was not permitted to be ambulatory until several days later. At the time of his discharge on July 24 the horizontal pressure was 120 systolic and 80 diastolic, the electrocardiogram was no different from that made on his original examination and roentgenograms showed only the changes usually associated with sympathectomy. Reexamination five months later revealed a horizontal blood pressure of 130 systolic and 80 diastolic, and no dyspnea on exertion. The patient was able to perform eight hours' work in a factory. Two and a half years later his status was the same.

Comment.—This case serves as an example of several of the dangers encountered in operations for hypertension. After an uneventful operation, atelectasis developed in a patient with advanced grade II hypertension, which fortunately responded satisfactorily to therapy. A further complication, the presence of a small amount of retropleural bleeding which was not massive enough to require aspiration and which did not materially influence the patient's course, was also noted. However, after each surgical procedure he showed evidence of general circulatory collapse which was attributable to alteration of the blood volume, decreased venous return and myocardial insufficiency. Pulmonary edema, peripheral circulatory failure and the presence of a shocklike state were evidence of this fact, as was the favorable response to measures designed to support blood volume and increase cardiac compensation. After the second operation this patient showed not only signs of cardiac failure but evidence of profound cerebral anoxia, as was well demonstrated by accentuation of previously undetected latent cerebral damage, unconsciousness and the appearance of spastic paraplegia. Heroic measures alone were able to save him after a stage operation for hypertension, and we were convinced that he would have failed to survive a one stage procedure. Despite his stormy convalescence, it

would appear that he has suffered no permanent cerebral damage from his experience, and clinically he has obtained a good result from the sympathetic denervation. The aid of the medical service in such cases is invaluable.

CASE 3.—E. G., a 52 year old Negro woman, entered St. Luke's Hospital on March 13, 1947, complaining of mild headaches, dizzy spells and some substernal pain which was precipitated by exertion or by emotional excitement. She gave no history of dyspnea or of episodes of cardiac decompensation.

On her entrance to the hospital, the patient's blood pressure was 230 systolic and 140 diastolic. Her heart was of normal size, though an electrocardiogram showed evidence of recovery from an old anterior coronary occlusion. After evaluation, her condition was diagnosed as early grade III hypertension, but since her pressure was still somewhat labile it was thought that she might benefit from surgical intervention.

Operation.—On March 22 sympathectomy from the ninth dorsal through the second lumbar ganglion was done on the right side, together with resection of the splanchnic nerve, without the production of pneumothorax. The patient left the operating room in good condition.

Postoperative Course.—Postoperatively the blood pressure was 110 systolic and 70 diastolic, the pulse rate was 100 and regular and the respiratory rate was 16. The morning after operation the temperature was 101 F., the pulse rate was 68 and the respiratory rate was 32. A slight cough had also developed, and there were rales present in the bases of both lungs. The evening of this same day the patient suddenly became cold and clammy, the pulse became rapid and despite supportive therapy she died.

Pathologic Examination.—This showed the presence of a recent thrombosis on the right coronary artery, with early infarction of the myocardium of the left ventricle and ventricular septum. The lungs showed moderate hyperemia and edema. The remainder of the changes were typical of relatively advanced hypertensive disease.

Comment.—It is, of course, open to speculation whether the operative load, a postoperative decrease in the rate of coronary blood flow combined with increased coagulability of the blood in the postoperative state or coincidence should bear the responsibility for this fatality. In any event the hazards of surgical intervention in patients with severe hypertension were clearly demonstrated.

CASE 4.—M. D., a 42 year old white woman, entered St. Francis' Hospital, Evanston, Ill., on Jan. 22, 1947, complaining of hypertension of three years' duration, recurrent attacks of headache, dizziness, tinnitus, epistaxis and occasional attacks of dyspnea, orthopnea and palpitation.

The past history revealed three previous normal pregnancies followed by a fourth pregnancy which had terminated in spontaneous abortion during the fifth month. The patient's blood pressure, however, was said to have been normal immediately after this abortion. She had had numerous surgical procedures performed, among which may be enumerated appendectomy, removal of the tubes and one ovary, cholecystectomy and gastroenterostomy.

On her entrance to the hospital the blood pressure was 170 systolic and 120 diastolic. Funduscopic examination revealed grade II retinopathy. The basal metabolic rate, the electrocardiogram and the roentgenogram of the chest were normal; chemical studies of the blood and renal function tests gave normal results. With administration of amobarbital sodium, the blood pressure fell to 110 systolic and 70 diastolic. Surgical intervention was recommended for grade II hypertension.

Operation.—On Feb. 6, 1947, sympathectomy from the eighth dorsal through the third lumbar ganglion, with resection of the splanchnic nerve, was done, and a renal biopsy was performed, which showed grade II hypertensive changes.

Postoperative Course.—The postoperative course was uneventful except for the presence of patchy atelectasis and mild pain in the area of the right loin until the sixth day, when pain in this area became so severe as to prevent sleep. For the succeeding three weeks the patient complained almost constantly of pain, which was only partially relieved temporarily by the use of acetylsalicylic acid, meperidine hydrochloride, pantopon® (a mixture of hydrochlorides of the opium alkaloids) alone or in combination with barbiturates, bromides or chloral hydrate. Several blocks of the right genitofemoral nerve and the intercostal nerves with procaine hydrochloride produced only temporary relief, while hot water bottles or local diathermy followed by massage and small doses of roentgen rays to the loin area produced no improvement. Hot sitz baths and support to the patient's back directly and by means of a fracture board beneath the mattress did provide some relief, although pain was present in some measure even at the time of her second operation.

Operation.—On Feb. 25, 1947, sympathectomy from the eighth dorsal through the third lumbar ganglion, together with splanchnic resection, was performed on the left side uneventfully.

Postoperative Course.—The postoperative course was uneventful except for the appearance of intercostal neuritis on the left side, which overshadowed the residual neuritic complaints remaining from the first operation. The various forms of therapy previously mentioned were again employed, but they provided only limited control of the pain. The patient left the hospital on March 4, with a blood pressure of 120 systolic and 80 diastolic, still suffering from some neuritic pain. She was followed at home by her family physician, who felt it necessary to employ codeine and acetylsalicylic acid for control of her pain and the routine use of barbiturates at night for a period of several months, until the question of drug addiction became a real one. It was only with difficulty that all medication was withdrawn.

It is interesting to note that menstruation, which had occurred only once in the preceding eighteen months in this patient, recommenced after her second operation, appearing at regular intervals and persisting for several months thereafter in the absence of any demonstrable pelvic disease.

Comment.—A patient who has undergone such a number and variety of operations is always seen with a somewhat skeptical eye by a consulting physician. However, the evidence of hypertensive vascular disease which had failed to respond to medical management and which appeared to be amenable to surgical measures urged the use of the latter. The possibility of reactivation of the ulcer for which the

previous gastroenterostomy had been performed has been kept in mind, but as yet this complication has not arisen. This type of case poses the difficult problem of determining the presence and severity of the pain of which the patient complains so bitterly. If time and the diagnostic use of placebos confirm the patient's story, the treatment of intractable neuralgia must be faced. Therapy, it must be admitted, is largely a matter of psychologic support combined with therapeutic trial and error until time brings relief. A desire to relieve the patient's pain must be wisely tempered by a healthy respect for the knowledge of the ease with which drug addiction can be produced in persistent cases. The relationship of menstruation to sympathectomy in this case may be coincidental, though removal of the sympathetic tonus to the vessels supplying the ovaries or uterus might occasionally produce a sufficientlv improved blood supply, so that increased or more regular menstrual flow might result.

Case 5.—V. B., a 32 year old white woman, entered St. Luke's Hospital on Feb. 3, 1947, complaining of high blood pressure of fifteen years' duration, occipital and frontal headaches, dizziness, spots in front of her eyes, fatigue, palpitation and some pain in the chest and dyspnea on moderate exertion.

Past History.—In 1941 this patient had undergone a subdiaphragmatic splanchnic resection elsewhere because of hypertension. After this she was confined to bed for almost two years and was unable to perform her housework because of weakness and chronic fatigue. She had also been troubled by severe sweating of the nondenervated portions of the body.

Examination.—On her entrance to the hospital examination revealed a slightly undernourished, nervous woman who appeared to be fairly well except for a blood pressure of 240 systolic and 120 diastolic. Although the roentgenograms of her chest and the pyelograms showed no abnormality and renal function was satisfactory, the electrocardiogram showed changes compatible with hypertensive cardiovascular disease. Examination of the fundi showed grade III arteriosclerotic retinopathy and the Rumpel-Leede test showed about 280 petechiae within a 1½ inch (3.8 cm.) radius. The patient was considered to have grade III hypertension, but it was felt that she might still receive some benefit from further sympathetic denervation.

Operation.—On February 15 sympathectomy from the eighth dorsal through the second lumbar ganglion, with removal of the supradiaphragmatic portion of the splanchnic nerve, was done on the left side and a renal biopsy was taken which showed focal scarring and nephrosclerosis of the kidney of an advanced type.

Course.—The patient returned from the operation in good condition, and the chest appeared to be well aerated. However, on the following day she complained of some incisional pain and had a temperature of 102.4 F.; the respiratory rate was increased, and some dulness was noted in the left side of the chest. After elevation of a mucous plug from the lung and with the help of penicillin therapy, all respiratory symptoms cleared up rapidly. For the first few days abdominal distention was noted, though there was no nausea or vomiting and the patient was passing gas rectally. She appeared to be apathetic and fatigued but had no significant complaints until the seventh postoperative day, when she

complained of pain in her incision. Some fluctuation was noted in the wound; aspiration yielded 30 cc. of bloody fluid, and smaller amounts were withdrawn on two subsequent occasions. A roentgenogram of the chest which was taken at this time showed no evidence of intrapleural disease. Three weeks later a roentgenologic examination of the chest showed an increased density in the left region extending up to the fourth rib anteriorly and obliterating the left border of the heart and diaphragm. The heart was displaced toward the right, and left hilar shadows were increased. Within the next three days 2,000 cc. of bloody serum was aspirated from the thoracic cavity. The patient was discharged on March 22 to complete her recovery before the second stage of her operation was performed. The second stage was later carried out, with an equally stormy convalescence.

Comment.—This case illustrates the severe incapacitation which may accompany even minimal sympathetic denervation in advanced cases. The severity of the patient's hypertensive status was paralleled by the marked evidence of increased capillary fragility. Though capillary fragility may have been favorably influenced by the preoperative use of rutin and vitamin C, a bleeding tendency may have been responsible for the complications seen during the convalescent period: abdominal distention, which may have resulted from retroperitoneal bleeding, formation of hematoma in the wound and possibly considerable intrapleural or retropleural accumulation of serosanguineous fluid. The increased incidence of these complications in other hypertensive patients suggests such causal relationship. The excessive and persistent hyperhydrosis of which the patient complained on her admission to the hospital represented the compensatory result of increased sympathetic tonus in the nondenervated portions of the body, and this was accentuated after completion of the surgical treatment, so that even mild Raynaud's phenomenon was at times noted in the upper extremity.

SUMMARY

The undesirable side effects of sympathectomy for hypertension are due to postural hypotension, compensatory accentuation of vasomotor tonus of the nondenervated portions of the body and alterations of sensory and motor innervation of the visceral organs. These may be expected to some degree in all cases.

The selection of cases of hypertension suitable for denervation is still so poorly understood that prediction of operative results in all cases is impossible. The contraindications to surgical treatment of hypertension depend basically on the degree of cerebral, cardiac and renal damage already sustained by the patient as well as on the condition of the peripheral vessels as demonstrated by the lability of the blood pressure to vasomotor tests.

Organic and physiologic changes in the cardiovascular, renal and cerebral systems will result in complications in a definite percentage

of patients subjected to sympathectomy for hypertension. Proper selection of cases will diminish the anticipated incidence, though in our experience this has amounted to 7 per cent. Severe, prolonged and intractable myalgia and neuralgia occurred postoperatively in 13 per cent of our cases despite extreme care and were the major cause of complaint on the part of the patients. Hydrothorax, hemothorax, pneumothorax and atelectasis were encountered in 23 per cent of our cases but were rarely a problem.

The postoperative morbidity rate of sympathectomy for hypertension was below 10 per cent and the mortality rate below 1 per cent.

Sympathectomy is of definite benefit in the treatment of hypertension, but the benefits must be weighed carefully against the inherent disadvantages, possible complications and at times uncertain results which will be encountered in any large group of even carefully selected cases.

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LUMBAR SYMPATHECTOMY FOR ARTERIOSCLEROTIC GANGRENE

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THE VALUE of sympathetic block with procaine hydrochloride and of lumbar ganglionectomy in the treatment of acute arterial occlusion due to accidental arterial laceration, embolism, thrombophlebitis and its sequelae, Raynaud's disease, hyperhidrosis and certain instances of Buerger's disease is now well established. The use of sympathectomy for arterial deficiency due to arteriosclerosis, however, has not been generally accepted because of the extensive and irreversible changes which occur in the arteries in this disease and the frequency of failure of this type of treatment in poorly selected cases.

In 1931 Flothow [1] reported 8 cases of arteriosclerosis of peripheral vessels in which improvement was obtained by injection of alcohol into lumbar sympathetic ganglions. Two of the patients had actual gangrene of one or more toes. In 1 of these the pain was relieved and the temperature of the skin raised 10 C. (18 F.). Although amputation was necessary at a later date "because of a functionally useless left leg," the disease appeared to be temporarily arrested by this procedure. In the second of the 2 cases of gangrene of the left great toe, the necrotic area "eventually cleared up" after injection of alcohol into the lumbar sympathetic ganglions. A diagnostic sympathetic block, with determinations of the cutaneous temperature, preceded the alcohol injections in each case. A troublesome alcohol neuritis occurred in most instances, lasting from two to six weeks.

In 1932 Robertson [2] reported the use of sympathectomy in a number of cases of impending gangrene from arteriosclerosis and intermittent claudication with numbness and pain in the extremities. When the

From the Surgical Service of the George Washington University Hospital and Gallinger Municipal Hospital.

1. Flothow, F. G.: Sympathetic Alcohol Injection for Relief of Arteriosclerotic Pain and Gangrene, Northwest Med. **30**:408-412 (Sept.) 1931.

2. Robertson, D. E.: Treatment of Vascular Diseases of the Extremities by Sympathectomy, J. Bone & Joint Surg. **14**:57-65 (Jan.) 1932.

arteriosclerosis was complicated by diabetes, pain was diminished by sympathectomy but ulcerations were not healed. Pain was relieved and more conservative amputations were possible when insulin therapy and sympathectomy were combined.

In 1937 Baker [3] reported the use of paravertebral injection of 95 per cent alcohol in a patient with arteriosclerotic gangrene of the distal half of the foot whose opposite leg had previously been amputated at midthigh for the same cause. Amputation of the other leg at midthigh level later became necessary, but the gangrenous process was temporarily retarded by the alcohol injection. Harris [4] in 1941 reported the results of lumbar sympathectomy in 13 cases of arteriosclerotic peripheral vascular disease. The temperature of the skin was determined after paravertebral block in each case. If a rise of 3 C. (5.4 F.) in the temperature of the skin could be obtained after block, Harris felt that a good result could be anticipated after sympathectomy. Sympathectomy was performed in most cases of severe peripheral arteriosclerosis, but it was his opinion that the operation should be carried out before ulceration or gangrene made its appearance, as these processes so greatly increase the demand for circulation. Among the 13 cases reported there were five good results, one fair result and seven poor results. In some patients showing little or no rise in the temperature of the skin after spinal anesthesia good results followed lumbar sympathectomy.

In 1941 Atlas [5] pointed out that conservative dilation therapy would not relieve peripheral ischemia unless the peripheral resistence to blood flow in the small vessel bed of the ischemic part was decreased by interruption of its sympathetic innervation. He also pointed out the danger of sympathectomy in advanced cases characterized by marked pallor of the foot on elevation or rubor on dependency, dry inelastic skin, venous filling of more than fifteen seconds and severe subjective and objective coldness of the foot without a rise in the temperature of the skin to 28 C. (82.4 F.) after sympathetic block. In such cases the collateral vascular network is incapable of hypertrophy and the small vessel bed is inflexible. The gangrenous process, if present, may rapidly increase after sympathectomy. Atlas reported 20 lumbar sympathectomies (performed by simple division of the trunk and burying of the lower end). There was immediate relief of severe persistent

3. Baker, W.: Alcohol Injection of Lumbar Sympathetic Ganglia in Arteriosclerosis of the Extremities, M. Ann. District of Columbia **6**:9-14 (Jan.) 1937.

4. Harris, R. I.: Obliterative Vascular Disease: Treatment by Sympathectomy, Canad. M. A. J. **45**:529-533 (Dec.) 1941.

5. Atlas, L. N.: Lumbar Sympathectomy in Treatment of Selected Cases of Peripheral Arteriosclerotic Disease, Am. Heart J. **22**:75-85 (July) 1941.

coldness, numbness and paresthesia and improvement in ulceration. Elevation of cutaneous temperatures of from 6.5 to 11.5 C. (11.7 to 20.7 F.) was obtained and improvement in oscillometric pulsations and intermittent claudication after a period of from six months to a year (when collateral circulation had developed).

Telford and Simmons[6] described the results of sympathectomy in 98 patients with peripheral arteriosclerosis at the Neurovascular Clinic of the Manchester Royal Infirmary during the past fifteen years. There were 4 deaths (1 due to alcoholism, 1 to duodenal ulcer and 2 to pulmonary embolism). Eigty-eight cases were followed closely. In 47 of these, in which sympathectomy was performed for intermittent claudication, there was some improvement in symptoms in all instances. Forty-one sympathectomies were performed for gangrene or incipient gangrene. In 21 cases there were good results (separation and healing of minor ulcerations enabling a life of reasonable activity after previous invalidism). In 20 cases the operation did not succeed and some form of amputation was later necessary. These amputations were often of a limited extent, however. Their results showed that if gangrene is more than trivial, sympathectomy should not be performed, especially if it is complicated by infection. In 2 cases there was distinct extension of the gangrenous process after operation.

De Takats, Fowler, Jordan and Risley[7] pointed out the inadvisability of sympathectomy in instances in which there is no increase in the temperature of the skin or rather a paradoxic fall following paravertebral block, as in such instances sympathectomy precipitates gangrene. When there is a rise in the temperature of the skin following paravertebral block as well as improvement in walking ability and shortening of the venous filling time, sympathectomy was deemed advisable. They divided patients in four classes, as follows:

1. Middle-aged persons with a walking ability of a few blocks and absence of popliteal or femoral pulsations. Good results were obtained after lumbar sympathectomy in 9 such patients.

2. Middle-aged or elderly persons with a walking ability of from one-half to two blocks showing some vascular stasis. Operations were performed on 10 such patients to prevent gangrene. Although there was no improvement in walking ability after operation, gangrene did not develop in any of these patients.

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6. Telford, E. D., and Simmons, H. T.: Sympathectomy in Peripheral Arteriosclerosis, Brit. M. J. **1**:386-387 (March 16) 1946.

7. de Takats, G.; Fowler, E. F.; Jordan, P., and Risley, T. C.: Sympathectomy in Treatment of Peripheral Vascular Sclerosis, J. A. M. A. **131**:495-499 (June 8) 1946.

3. Patients requiring amputation who had already had one leg amputated. Preliminary lumbar sympathectomy permitted amputation of the toes in 3 such patients and amputation of the lower part of the leg in 3, in instances formerly requiring supracondylar amputations.

4. Persons with intractible pain, diffuse osteoporosis and glossy edema typical of the causalgic state in whom the peripheral nerves were demyelinated in patches were operated on. Five such patients were improved after lumbar sympathectomy; none required amputations.

These investigators noted four results following sympathectomy in cases of arteriosclerosis: 1. The extremity warmed faster and cooled more slowly on direct exposure. 2. A high vasoconstrictor tonus in a standing or sitting position was abolished. 3. Vascular exercises and intermittent vascular hyperemia were more effective. 4. Any cross stimulation between sympathetic and demyelinated sensory fibers was abolished.

CLINICAL MATERIAL AND TECHNIC

Nineteen patients suffering from late peripheral arteriosclerosis with necrotic phenomena were subjected to lumbar sympathectomy. They ranged in age from 51 to 84 years. Fifteen patients were Negroes, 5 of them women, 2 were white women and 2 were white men. The significance of these comparative figures of race and sex is greatly distorted by the fact that the ratio of the population of the Gallinger Muncipal Hospital was approximately 3.2 Negroes to 1 white person for this period. Nine of the patients suffered from diabetes mellitus.

The elected type of operative procedure consisted of a muscle-splitting transverse incision at the level of the twelfth rib and the umbilicus. The external oblique muscle is split in the direction of its fibers, and the internal oblique and transversalis fibers are seperated at one time. The blunt dissection of the peritoneum away from the surgical area is facilitated by the lateral positioning of the patient, which introduces the effect of gravity on the peritoneum and its contents. The second and third lumbar ganglions are enucleated; the fourth ganglion, which was removed in the early cases, is now left intact.

LUMBAR SYMPATHECTOMY FOR ARTERIOSCLEROSIS WITH NECROSIS

PRESENTATION OF CASES

CASE 1.—I. K., a 65 year old white man, was admitted to the hospital on Feb. 17, 1947, with the diagnosis of diabetes and early arteriosclerotic gangrene of the left fourth and fifth toes. The right leg had been previously amputated at the midthigh. Pulsations of the popliteal, dorsalis pedis and posterior tibial arteries were absent. Sympathetic block of the second, third and fourth lumbar ganglions produced increase in temperature, with relief of pain. A lumbar sympathectomy

involving the second and third ganglions was performed on the left side on March 18, 1947. Discoloration of the affected toes disappeared. Follow-up examinations from the time of the operation until Jan. 20, 1948 revealed that the right foot exhibited the original response to sympathectomy. The foot remained warm, well healed and free of pain until January 23, when he was readmitted for mild cellulitis of the second right toe. The inflammation disappeared after three days of rest in bed.

CASE 2.—F. W., a 63 year old Negro, was admitted on Dec. 27, 1946, with the diagnosis of old cerebrovascular accident, general arteriosclerosis and a large superficial gangrenous area on the anterior surface of the left knee and the upper part of the leg. A roentgenogram showed no pathologic changes in the bone; arteriosclerosis of the femoral and tibial vessels was noted. Pulsations of the dorsalis pedis, posterior tibial and popliteal arteries were absent. The lesion gradually sloughed and extended in spite of adequate débridement and local treatment. On Jan. 23, 1947, a lumbar sympathectomy was performed on the left side. The extension of the ulceration ceased, and healing began. On March 4, a split thickness skin graft was applied successfully. The patient was discharged on May 1, completely healed. The last follow-up examination, on Feb. 5, 1948, revealed the area to be completely healed. The left extremity was warmer than the right, though the pulsation remained absent as originally.

Comment.—This is an example of a bizarre type of gangrene which was progressing until sympathectomy was performed. The operation was of definite value in permitting reparative grafting.

CASE 3.—M. S. O., a 78 year old Negro woman, was admitted to the hospital on April 6, 1947, with discoloration of the left first toe and the foot associated with roentgenologic evidence of arteriosclerosis of the aortic and leg vessels. There were no palpable pulsations of the arterial trunks below the knee. The left foot was cool and constantly painful. Lumbar sympathetic block caused decrease in pain and increase in temperature of the skin. On April 30, 1947, lumbar sympathectomy was performed on the left side. The discoloration and pain gradually disappeared. The patient was discharged from the hospital on May 9, 1947.

CASE 4.—D. D., a 51 year old Negro woman, was admitted to the hospital with the diagnosis of diabetes and arteriosclerotic gangrene of the distal half of the left foot. There was no pulsation of the dorsalis pedis artery, and pain was sharp and intermittent in character. Lumbar sympathetic block relieved the pain and increased the temperature of the skin slightly. The gangrene continued to extend. On Feb. 13, 1947, lumbar sympathectomy was performed on the left side. The gangrene continued to extend until it involved the lower half of the leg, when a supracondylar amputation was done. The stump healed without pain and remained warmer than the opposite thigh.

Comment.—This case represents a complete failure of ganglionectomy to interrupt or modify the extension of gangrene.

CASE 5.—C. F., a 53 year old Negro with diabetes, was admitted on March 21, 1947. A midthigh amputation of the right lower extremity had been carried out previously. The left foot showed ulceration and gangrenous discoloration of the middle toe. Poor pulsations were felt in the dorsalis pedis and posterior tibial vessels. With sympathetic block the temperature of the skin increased, and the amplitude of the pulsations was slightly increased by oscillometric measurement. Lumbar sympathectomy performed on the left side on April 4 gave a good

response. The toe was amputated at the time of the operation; the stump healed well. One month later the patient succumbed after an elective surgical procedure. The left lower extremity remained markedly improved during this time.

Comment.—Only the immediate effect could be noted in this case, which was prompt and definite.

CASE 6.—M. W., a 73 year old Negro woman, was admitted on June 27, 1947. Supracondylar amputation had been performed previously on the left side. The right foot was at first discolored about the heel, but then it became gangrenous and painful in this area. A sympathetic block produced a positive effect. On August 29 sympathectomy was performed on the right side. The discoloration disappeared, and the ulceration gradually healed completely. A follow-up check on Jan. 20, 1948, revealed that the foot had remained well healed; the effect of sympathectomy was evident. The psychologic effect was excellent since the patient was able to move about easily on crutches without pain.

Comment.—Sympathectomy seemed to interrupt the process and facilitate excellent healing in this instance.

CASE 7.—A. S., a 63 year old Negro man, was admitted on July 30, 1947, with the diagnosis of early gangrene of the great toe of the left foot due to arteriosclerosis. No pulsation was felt in any vessel below the femoral. The fundi showed arteriosclerotic changes. Several lumbar blocks had a positive effect. Lumbar sympathectomy performed on the left side on August 11 produced warming, relief of pain and disappearance of the discoloration of the great toe. Attempts at follow-up were unsuccessful.

Comment.—This case represents an excellent immediate response. It is unfortunate that later observations were not possible.

CASE 8.—E. F., a 53 year old diabetic Negro woman, was admitted on July 6, 1946, with arteriosclerotic ulceration at the base of the third and fourth toes. While she was in the hospital the ulceration progressed to include the second, third, fourth and fifth toes and the distal half of the lateral two thirds of the foot. The gangrene was so extensive that several members of our attending staff advised supracondylar amputation, but the patient consistently refused to submit to this. Amputation of the toes was consented to and was carried out on August 12. Because of poor healing of the stump, a lumbar sympathectomy was performed. The stumps healed rapidly after the operation.

Comment.—This case indicated that radical amputation is not necessary in many cases of extensive necrosis of the foot. Healing is implemented by sympathectomy.

CASE 9.—B. S., a 69 year old Negro woman, was admitted on March 6, 1947, with the diagnosis of diabetes and arteriosclerotic gangrene of the right second toe. The right third toe had been amputated for gangrene three years previously. No pulsations of the dorsalis pedis or posterior tibial arteries were present. The condition of the toe improved after rest in bed to the point where amputation was not considered necessary. Lumbar sympathetic block produced slight increase in the temperature of the skin. Lumbar sympathectomy was performed. Follow-up examinations, the last of which was made on Jan. 20, 1948, showed that the healing remained good, with a full response to sympathectomy.

Comment.—This case demonstrates that healing of the stump after amputation of the toe in instances of arteriosclerotic gangrene for at least three years is possible without sympathetic denervation. Also, it shows the difficulty of proper evaluation of the results of lumbar ganglionectomy in arteriosclerosis.

CASE 10.—I. S., a 76 year old Negro woman, was admitted on Sept. 26, 1946, with arteriosclerotic gangrene of the fourth and fifth toes of the right foot. Lumbar sympathetic block with procaine hydrochloride was carried out on October 22, with an immediate increase in the temperature of the skin. The dorsalis pedis and posterior tibial pulsations were absent. Lumbar sympathectomy was done on the right side on October 28. The toes were amputated subsequently, and the stumps healed well. Follow-up studies indicated that the response continued, with no change in the healing. The last check-up on Jan. 20, 1947, showed the affected foot well healed. The patient walked about without pain. The foot and leg were much warmer than the unaffected side.

Comment.—This result is good as far as healing is concerned and particularly in regard to duration of the sympathetic response.

CASE 11.—L. C., a 62 year old white woman, was admitted on July 16, 1947, with a seventeen year history of diabetes mellitus. An arteriosclerotic ulcer which had begun on the plantar surface of the right first toe six months before her admission had never healed and now consisted of a deep crater. The left great toe had been removed before at another hospital. The area around the crater became reddened, swollen and localized, and a large amount of thick yellow-white pus was finally evacuated. Roentgenograms showed evidences of osteomyelitis in the bones of the big toe. Pulsation of the dorsalis pedis was decreased but present. Though sympathetic block failed to increase the temperature, sympathectomy was carried out on August 7. It resulted in considerable warming of the right foot, with disappearance of pain. The ulcer and the incisions healed readily. A final check-up on Jan. 7, 1948, demonstrated the right foot to be well healed, free of pain and still much warmer than the left.

Comment.—This case shows the effect of sympathetic interruption on early necrosis and infection associated with arteriosclerosis. It may be noted that the patient recovered readily after amputation of another toe four years before, without ganglionectomy.

CASE 12.—J. H., a 67 year old Negro, was admitted on Jan. 8, 1945, with the diagnosis of arteriosclerotic ulcer of the right great toe. Pain was cramp-like in character, being present during the night. The dorsalis pedis and posterior tibial arterial pulsations were not palpable. Lumbar sympathectomy was performed on the right side on February 1. This eliminated the pain in the toe, but did not prevent a gas gangrene infection of the amputated toe stump, which necessitated a supracondylar amputation. The second and third lumbar ganglions on the left were also removed during the patient's stay in the hospital. A final check-up on Feb. 16, 1948, revealed the amputation stump to be well healed and free of pain. The left leg showed no abnormalities and was warm.

Comment.—This represents a failure of the operation to effectuate adequate healing of the amputated toe. Again it is interesting to note the duration of the effect of ganglionectomy.

CASE 13.—H. H., an 84 year old Negro woman, was admitted on July 16, 1947, with gangrene of the fourth and fifth toes and controlled diabetes mellitus. She had complained for several months of severe lancinating pain at night and during poor weather. No dorsalis pedis or posterial tibial pulsations were present. On August 8 lumbar sympathectomy on the right side and amputation of the right third, fourth and fifth toes were done. This resulted in marked relief of pain and progressive though slow healing of the amputation stumps. A

final check-up on Feb. 17, 1948 found the patient free of pain and walking about with the help of a cane. The stumps had remained well healed, and the effect of sympathetic denervation was still definite.

Comment.—In view of the age of the patient and the severity of the organic process, this is to be considered a noteworthy result.

Case 14.—A. A., a 70 year old white man, was admitted on Dec. 5, 1947, with gangrene of the right second, third, fourth and fifth toes which had become apparent ten days previously. Sympathetic block gave a good response. No dorsalis pedis or posterior tibial pulsations were present. The gangrene spread to include all of the foot. Lumbar sympathectomy was finally performed on the right side on December 22, together with amputation below the knee. The stump healed well, and the leg remained warm and of larger size than the unaffected leg.

Comment.—Sympathectomy probably was important in preserving the knee joint for a successful amputation below the knee.

Case 15.—M. J., a 57 year old Negro woman with severe diabetes, was admitted on May 10, 1947, with early gangrene of the left foot. Sympathetic block and sympathectomy were completely unsuccessful in limiting the necrotic process. Consequently, a supracondylar amputation was carried out. The stump healed well. A final check-up on Feb. 5, 1948, revealed the stump to be well healed.

Comment.—This case is an example of failure of the operation to affect the necrotic process.

Case 16.—P. P., a 71 year old Negro man, was admitted with an arteriosclerotic gangrenous ulcer at the base of the great toe. Sympathetic block produced striking relief of pain and slight increase in the temperature of the skin. Lumbar sympathectomy performed on the right side on June 2, 1947, produced a good immediate result consisting of pronounced decrease in pain, healing of the ulcer and good increase in the temperature of the skin. However, he was readmitted on July 17 with a recurrence of the ulcer. The gangrene progressed despite all measures, and a supracondylar amputation was resorted to. The stump healed well.

Comment.—This case must be considered as a failure. Because of the time interval it is doubtful that the operation precipitated the gangrene, but the relationship may be questioned.

Case 17.—D. S., a 70 year old Negro woman, was admitted with a history of severe nocturnal pain in the right foot and gangrene of the right fourth toe. The right foot was much cooler than the left; dorsalis pedis and posterior tibial pulsations were absent. Sympathetic block gave a good response. Sympathectomy and amputation of the toe were carried out on Feb. 12, 1948. The immediate effects were good in terms of cessation of pain and beginning of healing.

Case 18.—S. W., a Negro woman aged 62, was admitted on Sept. 28, 1946, with a history of diabetes, extensive generalized arteriosclerosis and the presence of gangrene involving the fourth and fifth toes and circumscribing the foot. Lumbar blocks gave a good response. Penicillin and local treatment showed no effect. Lumbar sympathectomy, which was performed on November 19 produced healing of the area after amputation of the fifth toe and skin grafting of part of the defect. Osteomyelitic changes in the bone, which were demonstrated on the preoperative roentgenograms, regressed also. A final check-up on Jan. 20, 1948, showed the healing to be complete. The patient was free of pain and walked about easily without support.

CASE 19.—E. S., a 62 year old diabetic white woman, was admitted on May 13, 1947, with symptoms of intermittent claudication of both feet and ulceration of the dorsum of the right foot. There was an excellent response to sympathetic block bilaterally. Bilateral sympathectomy was carried out. The result was excellent; a marked decrease in the degree of claudication, healing of the ulcer and continuous increase in the temperature of the skin were demonstrated. A check-up on Feb. 5, 1948 showed no change in the excellent response.

SUMMARY

Nineteen patients suffering from peripheral arteriosclerosis with evidence of tissue necrosis were subjected to lumbar ganglionectomy. The period of postoperative follow-up ranged from one month to thirty-eight months. In the patients who were improved the effect of sympathectomy persisted throughout the period of observation.

Results of Lumbar Ganglionectomy in Nineteen Patients

Patient	Age	Months Followed	Result	Diabetes
I. K.	65	11	Healed	Present
F. W.	63	13	Healed	Absent
M. S.	78	Amputation	Amputation	Absent
D. D.	51	Amputation	Amputation	Present
C. F.	53	Death 1 month after operation	Died	Present
M. W.	73	6	Healed	Absent
A. S.	63	6	Healed	Absent
E. F.	53	17	Healed	Present
B. S.	69	11	Healed	Present
I. S.	76	16	Healed	Absent
L. C.	62	6	Healed	Present
J. H.	67	38	Healed	Absent
H. H.	84	6	Healed	Present
A. A.	70	2	Healed	Absent
M. J.	57	Amputation	Amputation	Present
P. P.	71	Amputation	Amputation	Absent
D. S.	70	1	Healed	Absent
S. W.	62	14	Healed	Present
E. S.	62	8	Healed	Present

In 14 of the cases the denervation produced an improvement, with healing of the necrotic area. In the remaining 5 cases failure was evidenced by the progression of the necrosis, which made amputation necessary.

Sympathetic block with procaine hydrochloride was used routinely. Though in most cases the injection indicated the expected operative effect, it was not uniformly dependable. It was our conclusion that a negative effect of sympathetic block did not necessarily indicate that there would be failure. This fact certainly undermines the value of preoperative injection of procaine hydrochloride as a test.

Though 9, or 48 per cent, of our patients had diabetes, there seemed to be no specific relationship between the result obtained and the presence or absence of diabetes, as indicated in the accompanying table which summarizes the results.

CONCLUSIONS

It is difficult to draw accurate conclusions from the clinical study of small groups of patients when controls cannot properly be established. Consequently, despite careful study of these cases, we can only state that the enucleation of the second and third lumbar ganglions with the intervening sympathetic trunk produced improvement in 73 per cent of patients with late manifestations of arteriosclerosis. In the remaining 27 per cent the procedure failed to influence the necrotic process. To interpret the degree of improvement in the patients who benefited is most difficult. Therefore, we have simply considered as improvement the healing of the necrotic process with or without minimal loss of tissue, as in amputation of a toe with healing of the stump. The accompanying increase in the temperature of the skin and the decrease in pain have evaded satisfactory comparative interpretation.

The employment of sympathectomy in cases in which major amputation is required may allow for an occasional amputation below the knee. However, in the large majority of cases in which amputation must ensue despite sympathectomy the supracondylar procedure becomes imperative.

Further studies are needed to establish adequate controls for clinical impressions. In addition, there is a crying need for the establishment of criteria of indications and contraindications for lumbar sympathectomy. Adequate standardization will be arrived at when a series of cases sufficiently large to be statistically important can be studied.

SURGICAL CONSIDERATIONS IN HEMORRHAGE OF THE UPPER PART OF THE GASTROINTESTINAL TRACT

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THE OCCURRENCE of massive hemorrhage from the stomach or the upper part of the small bowel presents a difficult problem to the clinician. A diagnostic problem is immediately presented because of the great variety of conditions which may produce such bleeding. A therapeutic problem is raised because of the lack of specific measures available for control of such hemorrhage and because of the existing differences of opinion regarding the proper treatment.

The existence of differences of opinion regarding the treatment of hemorrhage from the upper part of the gastrointestinal tract, especially in regard to the indications for surgical intervention in patients with bleeding peptic ulcer, has prompted us to report our experience with cases in a large charity institution.

MATERIAL

A total of 305 patients was studied, who entered the Cook County Hospital because of gross melena, hematemesis or both. These patients were admitted during the three year period from 1943 to 1945 inclusive. In each instance the hemorrhage constituted the chief complaint.

The patients included in the present study represent a group with rather severe conditions, as is indicated by the fact that 40 per cent had a red blood cell count below 2,500,000 on their admission and 26 per cent had fainted as a result of their bleeding.

Of the 305 patients, 230 had bleeding from a gastroduodenal ulcer, while 75 bled from nonpeptic ulcer or from extragastric causes.

SEX, RACE AND AGE DISTRIBUTION

In this series bleeding from the upper part of the gastrointestinal tract occurred much more commonly in men than in women. In the 230 cases of bleeding peptic ulcer 83.5 per cent of the patients were men and 16.5

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per cent women. Of the 75 patients without ulcers, 78.7 per cent were men and 21.8 per cent women (table 1).

Of the patients with ulcer, 176 were white, 52 were Negroes, 1 was Chinese and 1 Japanese. In the group of patients without ulcers there were 62 white persons and 13 Negroes (table 2).

The patients with bleeding peptic ulcer ranged in age from 20 to 83 years. Fifty-eight per cent were between the ages of 40 and 60. The patients without ulcer had a somewhat higher average age, the range being from 20 to 80 years and 77.3 per cent being between the ages of 40 and 70 (table 3).

TABLE 1.—*Sex Distribution in 305 Cases of Bleeding in the Upper Part of the Gastrointestinal Tract*

	Ulcer		No Ulcer	
Sex	Number of Cases	Percentage	Number of Cases	Percentage
Male	192	83.5	59	78.7
Female	38	16.5	16	21.3

TABLE 2.—*Race Distribution*

	Ulcer		No Ulcer	
Race	Number of Cases	Percentage	Number of Cases	Percentage
White	176	76.4	62	82.7
Negro	52	22.74	13	17.3
Chinese	1	0.43	0	0
Japanese	1	0.43	0	0

CAUSE OF BLEEDING IN THE UPPER PART OF THE GASTROINTESTINAL TRACT

In the 305 cases studied there were 11 different diagnoses made of the cause of bleeding, and in 7 cases the source of bleeding could not be determined with any degree of certainty (table 4).

A diagnosis of bleeding peptic ulcer was made in 230, or 75.6 per cent, of the cases. The site of the ulcer was determined in 46.8 per cent of the patients, being duodenal in 58 per cent, gastric in 27.4, marginal in 10 and both gastric and duodenal in 4.6.

Bleeding esophageal varices due to portal cirrhosis of the liver was the diagnosis second in frequency, with an incidence of 9.8 per cent. A diagnosis of acute gastritis was made for 5.1 per cent of the patients. Carcinoma of the stomach was next in frequency and accounted for 4.9 per cent of the cases in which there was bleeding. There was 1

case each of the following conditions: polyp of the stomach, carcinoma of the duodenum, primary carcinoma of the liver with thrombosis of the portal veins and bleeding esophageal varices, thrombocytopenic purpura, Banti's syndrome, syphilitic cirrhosis of the liver with bleeding esophageal varices and a large diverticulum of the duodenum in which no other source of bleeding was found.

TABLE 3.—*Age Distribution and Relation to Mortality*

	Ulcer			No Ulcer		
Age in Years	Number of Patients	Number Who Died	Mortality, Percentage	Number of Patients	Number Who Died	Mortality, Percentage
10 to 19	0	0	0	0	0	0
20 to 29	20	1	5	3	1	33.3
30 to 39	32	2	6.3	5	0	0
40 to 49	68	4	7.3	25	11	44.0
50 to 59	66	7	10.3	18	8	44.4
60 to 69	33	10	29.4	15	8	53.3
70 and over	11	4	36.4	9	7	77.8

TABLE 4.—*Etiologic Factors in Bleeding of the Upper Part of the Gastrointestinal Tract*

Diagnosis	Number of Cases	Percentage	Mortality, Percentage
Peptic ulcers, total	230	75.6	12.2
Duodenal	63	....	....
Gastric	30	....	....
Marginal	11	....	....
Gastric and duodenal	5	....	....
Site not recorded	121	....	....
Portal cirrhosis of the liver	30	9.8	63.3
Acute gastritis	16	5.1	5.0
Carcinoma of the stomach	15	4.9	60.0
Miscellaneous	7	2.3	71.4
Polyp of stomach	1	....	....
Carcinoma of duodenum	1 (died)	....	....
Primary carcinoma of liver with portal vein thrombosis	1 (died)	....	....
Thrombocytopenic purpura	1 (died)	....	....
Banti's syndrome	1 (died)	....	....
Syphilitic cirrhosis of liver	1 (died)	....	....
Diverticulum of duodenum	1	....	....
Diagnosis undetermined	7	2.3	....

There are a number of other conditions which may produce hematemesis or melena but which were not encountered in this series. Among these are hiatus hernia, tumors or diverticula of the small bowel, benign tumors of the stomach (especially leiomyomas) and mucosal tears in the cardia of the stomach due to violent vomiting or retching. Weiss and Mallory [1] have reported several fatal cases of the last condition, the chief clinical manifestations of which were persistent vomit-

1. Weiss, S., and Mallory, G. K.: Lesions of Cardiac Orifice of Stomach Produced by Vomiting, J. A. M. A. **98**:1353-1355 (April 16) 1932.

ing and retching, frequently precipitated by alcoholic debauches and associated with massive hematemesis.

In 7 cases the site of the bleeding was not determined. It is often impossible to determine the cause of bleeding clinically and occasionally even at laparotomy and at necropsy. Thus Jankelson [2] reported a case with a long history of ulcer, two previous gastric operations and finally fatal hematemesis for which the autopsy revealed no demonstrable cause.

DIAGNOSIS

In making a diagnosis of peptic ulcer as the cause of bleeding, the past history is of importance. Of the 230 patients with bleeding peptic ulcer in this series, 82.4 per cent had a definite history of previous symptoms of ulcer. In only 17.6 per cent had there been no previous indication of peptic ulcer. A previous medical diagnosis had been made in 51 per cent of the cases and a previous roentgenologic diagnosis in 18 per cent. In 7 per cent of the patients a previous operation for peptic ulcer had been performed. Of the 16 patients with peptic ulcer who had undergone surgical treatment for peptic ulcer, 5 had been subjected to repair of a perforation, 7 to gastroenterostomy and 4 to gastric resection.

The roentgenogram made after a barium meal showed evidence of ulcer in 54 per cent of the 124 cases of ulcer in which such roentgenograms were recorded. In most cases barium meal studies were not done until there had been no evidence of bleeding for a period of at least ten days. The reasons for the frequency of normal roentgenograms after a barium meal following bleeding probably caused by ulcer are manifold. The ulcer might have been acute and shallow; it might have healed sufficiently to prevent barium from filling the crater; it might be in a so-called blind spot, or it might be filled with debris or blood. One of the explanations is illustrated by a case in the present series. In this case a barium meal roentgenogram made ten days after bleeding had ceased showed a normal condition. However, gastroscopy demonstrated a gastric ulcer crater which appeared to be evenly filled with a blood clot.

Gastroscopy is an important aid in determining the site of bleeding. It was performed in 30 of the patients with peptic ulcer and demonstrated the ulcer in 8. In each of the 8 cases the ulcer was of the gastric type. In 1 additional case intense gastritis indicative of a stomal ulcer was seen at the gastroenterostomy opening. In 4 cases gastroscopy revealed an ulcer which escaped detection by the roentgenogram made after a barium meal. In 2 cases gastroscopy gave negative results and roentgenologic study revealed gastric ulcer (table 5). These findings indicate that both barium meal studies and gastroscopy should be

2. Jankelson, I. R.: Gastroenterology **9**:472-475, 1947.

done in cases of bleeding of the upper part of the gastrointestinal tract in order to locate the site of the bleeding in the greatest number of patients possible.

The diagnosis of portal cirrhosis with bleeding from esophageal varicosities was in most cases made clinically on the basis of signs of advanced disease of the liver. Palpable enlargement of the liver was recorded in 60 per cent of the 30 cases of cirrhosis of the liver. Ascites was present in 30 per cent, edema of the extremities in 13 per cent, dilated superficial abdominal veins in 16.6 per cent, palpable spleen in 10 per cent and jaundice in 3.3 per cent. Patients with melena alone are unlikely to be bleeding from esophageal varicosities. In this series of cases all 30 with portal cirrhosis of the liver had hematemesis. In contrast, 24 per cent of the patients with bleeding peptic ulcer had only melena.

TABLE 5.—*Results of Gastroscopy in 30 Cases of Bleeding Peptic Ulcer*

Final Diagnosis	Number of Cases	Gastroscopy		Roentgenologic Study	
		Positive Results	Negative Results	Positive Results	Negative Results
Gastric ulcer	10	8	2	6	4
Duodenal ulcer	9	0	9	9	0
Marginal ulcer	1	1*	0	0	1
Peptic ulcer by clinical diagnosis and previous roentgenologic study	10	0	10	0	10

* Intense gastritis at the stoma was present.

The importance of gastritis as a cause of bleeding has been demonstrated by Benedict [3] and others. Benedict also pointed out the frequent association of gastritis with duodenal ulcer and the difficulty of determining in such cases whether the bleeding is coming from the ulcer or the gastritis.

A diagnosis of gastritis in the absence of gastroscopy is not definite. Of the 16 patients with gastritis in our series, only 7 were given gastroscopic examination. Of these, 3 showed multiple shallow gastric erosions with bleeding, 2 showed hypertrophic gastritis with pseudopolypi and 2 showed atrophic gastritis. The remaining patients belong to a group seen at Cook County Hospital who present themselves after an alcoholic debauch with symptoms of epigastric pain and vomiting of blood and who have no history or symptoms suggestive of peptic ulcer or of other known causes of bleeding of the upper part of the gastrointestinal tract.

As has been shown, peptic ulcer, portal cirrhosis of the liver, acute gastritis and carcinoma of the stomach are the most common causes

3. Benedict, E. B.: Am. J. Roentgenol. **47**:254-261, 1942.

of this condition. The seven rarer causes of bleeding represented in this series illustrate the importance of careful examination and laboratory study of patients with hematemesis or melena.

The patient with bleeding from a polyp of the stomach was a 66 year old man who entered the hospital in shock with a blood pressure of 96 systolic and 40 diastolic after having hematemesis and melena for three days. The diagnosis was made by gastroscopy after two barium meal roentgenograms had shown no abnormality. The diagnosis of carcinoma of the duodenum was made at operation, at which time a gastroenterostomy was done for the relief of obstruction.

The patient with carcinoma of the liver and thrombosis of the portal veins presented the picture of drowsiness, coma, jaundice, hematemesis and oliguria. Spider telangiectases were noted, and the clinical diagnosis of acute yellow atrophy of the liver was considered. The final diagnosis was made at autopsy. Retrograde thrombosis of the portal veins arising in an area of primary carcinoma of the liver and bleeding esophageal varices were found.

The case of Banti's syndrome involved a 20 year old youth who had long-standing splenomegaly and who, in addition to massive hematemesis, had enlargement of the liver, ascites and anemia. At autopsy old thrombosis of the portal veins with cirrhosis of the liver and enlargement and fibrosis of the spleen were found.

The diagnosis of thrombocytopenic purpura was made for a 40 year old woman, who in addition to having hematemesis and melena had had a missed abortion. She had a platelet count of 1,200, a prolonged bleeding time and a normal clotting time, and sternal biopsy revealed signs compatible with the diagnosis of thrombocytopenic purpura. This patient died thirty days after splenectomy.

The diagnosis of syphilitic cirrhosis of the liver with bleeding esophageal varices was made at autopsy on a 56 year old man for whom a clinical diagnosis of bleeding peptic ulcer had been made. At postmortem examination a healed duodenal ulcer was found in addition to syphilitic cirrhosis and bleeding esophageal varices. This case illustrates the fact that a history of peptic ulcer and a deformed duodenal bulb do not always mean that an ulcer is the cause of the bleeding.

The patient with possible bleeding from a duodenal diverticulum was a 69 year old man with no past history of gastrointestinal complaints who entered the hospital after vomiting dark bloody material six times in three days and having tarry stools for three days. The blood pressure on admission was 164 systolic and 94 diastolic, and the red blood cell count was 2,500,000. The only positive finding was a large diverticulum of the second portion of the duodenum demonstrated by the roentgenogram made after a barium meal. The patient received two blood transfusions and made an uneventful recovery.

PROGNOSIS OF BLEEDING IN THE UPPER PART OF THE GASTROINTESTINAL TRACT

The mortality associated with the various causes of bleeding found in our series of patients is shown in table 4. It can be seen that the over-all mortality for patients with bleeding peptic ulcer was 12.2 per cent.

Bleeding from esophageal varices due to portal cirrhosis of the liver had a high mortality, 63.3 per cent. Various methods of therapy for such hemorrhage have been advocated. The injection of sclerosing solutions into the varicosities has been used by Moersch,[4] Patterson and Rouse,[5] Welt and Blatteis[6] and others. However, temporary arrest of hemorrhage is the most that can be expected as long as the underlying portal hypertension is present. Recently Rowntree[7] and his associates have described a method of employing internal venous tamponage in the esophagus by means of a latex bag inflated in the esophagus. Som and Garlock[8] have recently described another method, which involves the performance of posterior mediastinotomy to create a new collateral circulation between the submucosal and periesophageal veins of the esophagus and the deeper veins of the mediastinum. The surgical establishment of a portacaval shunt, as developed by Whipple[9] and Blakemore and Lord,[10] is effective in reducing portal hypertension caused by portal cirrhosis of the liver. Phemister[11] has emphasized the importance of varicosities in the cardia of the stomach which may accompany esophageal varices and produce hemorrhage; he describes a method for the surgical treatment of esophageal varices by esophagogastric resection. The high mortality from bleeding of esophageal varicosities certainly justifies radical attempts at treatment.

The mortality rate for the patients with gastritis who had bleeding was 5 per cent. The hospital mortality rate among the patients with bleeding from carcinoma of the stomach was 60 per cent. Of the 7 patients with other more rare causes of bleeding, 5 died. Of the 7 patients with bleeding of undetermined origin, 2 died.

4. Moersch, H. J.: J. Thoracic Surg. **10**:300-309, 1941.

5. Patterson, C. O., and Rouse, M. O.: Injection Treatment of Esophageal Varices, J. A. M. A. **130**:384-386 (Feb. 16), 1946.

6. Welt, B., and Blatteis, S. R.: Am. J. Surg. **63**:415-417, 1944.

7. Rowntree, L. G.; Zimmerman, E. F.; Todd, M. H., and Ajac, J.: Intra-esophageal Venous Tamponage: Its Use in Case of Varical Hemorrhage from Esophagus, J. A. M. A. **135**:630-631 (Nov. 8) 1947.

8. Som, M. L., and Garlock, J. H.: New Approach to Treatment of Esophageal Varices, J. A. M. A. **135**:628-629 (Nov. 8) 1947.

9. Whipple, A. O.: Ann. Surg. **122**:449-475, 1945.

10. Blakemore, A. H., and Lord, J. W., Jr.: Ann. Surg. **122**:476-489, 1945.

11. Phemister, D. B., and Humphreys, W. M.: Ann. Surg. **126**:397-410, 1947.

FACTORS RELATED TO THE PROGNOSIS FOR PATIENTS WITH BLEEDING PEPTIC ULCER

The foregoing paragraphs have emphasized the variety of conditions which can produce melena or hematemesis. It can be seen that many of these conditions cannot be benefited by surgical treatment and that, therefore, when an operation to stop bleeding is being considered a fairly definite diagnosis of the source of the bleeding must first be made. In the consideration of surgical intervention, it is also of importance to be able to estimate a given patient's chances to survive under medical treatment.

Age is one of the factors having the greatest effect on the mortality of bleeding peptic ulcer. Table 3 shows that in the present series there was a progressive increase in mortality with increasing age. There were 120 patients under the age of 50, of whom 7 died, a mortality rate of 5.8 per cent. There were 110 patients over the age of 50, of

TABLE 6.—*Relation of Number of Previous Hemorrhages to Mortality*

Number of Previous Hemorrhages	Ulcer			No Ulcer		
	Number of Patients	Number Who Died	Mortality, Percentage	Number of Patients	Number Who Died	Mortality, Percentage
0	140	12	9.2	55	28	50.9
1	56	9	15.8	13	3	23.1
2	8	3	37.5	5	3	60.0
3	9	1	11.1	0	0	0
4 or more	17	2	12.8	2	0	0

whom 21 died, a rate of 19.1 per cent. The sharpest rise in mortality occurred at about the age of 60. Of the 44 patients over the age of 60, 14 died, a mortality rate of 31.8 per cent.

The number of previous hemorrhages has often been shown to be a factor influencing the mortality of bleeding peptic ulcer. In the present series the relation between the number of previous hemorrhages and mortality was not striking (table 6). There were not enough patients with more than one previous episode of bleeding to make the figures statistically significant. However, it may be seen that the mortality rate among 142 patients who were having their first episode of bleeding was 9.2 per cent, whereas that among the 106 patients with previous bleeding was 15.8 per cent.

Certain symptoms seemed to be related to an increase in mortality. Among the 47 patients having fainting as a symptom there was a mortality rate of 21.3 per cent as compared to 12 per cent for the entire group of patients with bleeding peptic ulcer. Pain in the back was complained of by 7 patients, and of these, 2 died. It is known that a posterior penetrating ulcer which erodes the gastroduodenal or the superior

pancreaticoduodenal artery is one of the common sources of bleeding which continues in spite of medical treatment, and therefore pain in the back might be expected to indicate an intractable type of bleeding. Diarrhea was present in 32 patients, 18.7 per cent of whom died. It is logical that the mortality rate among patients having enough bleeding into the gastrointestinal tract to produce a bloody diarrhea should be higher than the average.

TABLE 7.—*Relation of Blood Pressure on Admission to Mortality in 286 Cases of Bleeding of the Upper Part of the Gastrointestinal Tract*

	Ulcer			No Ulcer		
Blood Pressure	Number of Cases	Deaths	Mortality, Percentage	Number of Cases	Deaths	Mortality, Percentage
Normal, systolic 100 to 150, diastolic 60 to 90.	178	15	8.4	52	25	48
Low, systolic, 90 or below	43	16	37.2	8	6	75
High, systolic over 170, diastolic over 90	4	0	0	1	1	100

TABLE 8.—*Relation of Red Blood Cell Count on Admission to Mortality*

	Ulcer			No Ulcer		
Red Blood Cell Count	Number of Cases	Deaths	Mortality, Percentage	Number of Cases	Deaths	Mortality, Percentage
4,500,000	20	2*	10	5	2	40
4,000,000 to 4,500,000	20	1	5	7	1	14.3
3,500,000 to 4,000,000	28	0	0	9	2	22
3,000,000 to 3,500,000	31	2	6.5	10	5	50
2,500,000 to 3,000,000	33	1	3.0	9	8	88
2,000,000 to 2,500,000	35	7	20	6	2	33.3
1,500,000 to 2,000,000	35	6	17.1	5	3	60
1,000,000 to 1,500,000	14	3	21.4	3	2	66.6
Below 1,000,000	4	2	50	0	..	....

* In 1 case the red blood cell count dropped to 1,600,000 and operation was performed.

The blood pressure on admission gives some indication of the severity of the bleeding and of the mortality to be expected (table 7). Among the 178 patients with a systolic blood pressure of 100 or above the mortality was 8.4 per cent, whereas in the 43 patients with a systolic blood pressure below 100 the mortality was 37.2 per cent. There were only 4 patients in the series who had hypertension on admission, and in this group there were no deaths. A definite correlation was found between the red blood cell count on admission and the mortality, as is shown in table 8.

A relation was found between the blood nonprotein nitrogen level and the mortality of bleeding peptic ulcer (table 9). In the 78 patients

with a nonprotein nitrogen level of 50 or below there was a mortality of 2.6 per cent, while in the 32 patients with a level between 50 and 100 there was a mortality of 12.5 per cent. There were only 2 cases in which a determination of the nonprotein nitrogen showed a value over 100, and both of the patients died. In almost all instances in which the nonprotein nitrogen was increased the creatinine level of the blood was normal or only slightly above it. It is known that free blood in the gastrointestinal tract will produce an increased blood nonprotein nitrogen content. This has been demonstrated experimentally by Kaump and Parsons.[12] Schiff [13] and his associates have shown that digestion of blood from the gastrointestinal tract leads to an increase of the blood urea nitrogen which is proportional to the amount of blood in the bowel. They also showed that the blood urea nitrogen level remains increased for only twenty-four to thirty-six hours from one episode of bleeding. These findings suggest that repeated determina-

TABLE 9.—*Relation of Nonprotein Nitrogen Level on Admission to Mortality in 140 Cases of Bleeding of the Upper Part of the Gastrointestinal Tract*

	Ulcer			No Ulcer		
Nonprotein Nitrogen	Number of Cases	Deaths	Mortality, Percentage	Number of Cases	Deaths	Mortality, Percentage
50 or below	78	2	2.6	18	6	33.3
50 to 100	32	4	12.5	10	5	50.0
Over 100	2	2	100.0	0	0	0

tions of the blood urea nitrogen level are of value in estimating recurrence of bleeding from a peptic ulcer and that this method should be used more often. Persistent high levels of nonprotein nitrogen may also result from damage to the kidney during the period of shock from the initial severe bleeding.

In determining the prognosis for a patient with a bleeding peptic ulcer the response to a short trial of medical treatment is of great importance. In the group of patients in this series it was apparent that the prognosis for those who continued to bleed or had a recurrence of bleeding after forty-eight hours of medical treatment was poor. There were 14 such patients who were treated medically, and 8 died, a mortality of 58 per cent. Fifteen patients who continued to bleed or had recurrence of bleeding after forty-eight hours of medical treatment were operated on, and of these, 5 died, a mortality rate of 30 per cent (table 10).

12. Kaump, O. H., and Parsons, J. C.: Am. J. Digest. Dis. **7**:191-194, 1940.
13. Schiff, L.; Stevens, R. J., and Mass, H. K.: Am. J. Digest. Dis. **9**:110-113, 1942.

Heuer [14] stated that in differentiating patients with fatal and nonfatal types of hemorrhage the most important criterion is the failure to improve promptly under a strict medical regimen. He, moreover, expressed the belief that if surgical intervention is chosen it should be done within the first twenty-four to forty-eight hours after the onset of the hemorrhage. The importance of early operation was originally stressed by Finsterer,[15] Gordon-Taylor [16] and Allen.[17] Since in most instances it is difficult to determine which patients will not respond to medical treatment in less than forty-eight hours, it would seem to us that most of the emergency operations should be performed between forty-eight and seventy-two hours after the onset of the bleeding, although earlier surgical intervention may be necessary in rare cases. In some patients the presence of an associated complication, e. g., obstruction, large crater or intractable pain, may influence the decision to intervene surgically. Patients who apparently stop bleeding during

TABLE 10.—*Course of 29 Patients with Bleeding Peptic Ulcer Who Continued to Bleed or Had Recurrence of Bleeding After Forty-Eight Hours of Treatment on Medical and Surgical Regimen*

Type of Treatment	Number of Patients	Number Who Died	Mortality, Percentage
Medical treatment	14	8	57.8
Surgical treatment	15	5	33.0

the first forty-eight hours of medical treatment and then have a recurrence of massive bleeding four or five days later are also candidates for surgery, since their prognosis under medical treatment is poor.

The fact that in the present series of cases 50 per cent of the fatalities occurred during the first three days in the hospital is another indication that an early decision regarding surgical intervention should be made.

RESULTS IN MEDICALLY TREATED PATIENTS WITH BLEEDING PEPTIC ULCER

The mortality rate among 204 patients with bleeding peptic ulcer treated medically was 11.3 per cent. Of the 14 patients who continued to bleed or had recurrence of bleeding after forty-eight hours of medical treatment and who were not operated on, 8 died, a mortality rate of 58 per cent.

14. Heuer, G. J.: New England J. Med. **235**:777-783, 1946.
15. Finsterer, H.: Lancet: **2**:303-305, 1936.
16. Gordon-Taylor, G.: Brit. J. Surg. **33**:336-345, 1946.
17. Allen, A. W.: Surgery **2**:713-731, 1937.

RESULTS IN SURGICALLY TREATED PATIENTS WITH BLEEDING PEPTIC ULCER

In any discussion of the operative treatment of patients with bleeding peptic ulcer it is essential to distinguish between surgical procedures performed during active bleeding and those performed after bleeding has ceased. As is shown by others [18] and by our series, emergency surgical intervention during active bleeding carries an appreciable mortality and should be reserved for only a few carefully selected patients, whereas an interval operation can be done with a low mortality.

A number of difficulties may be encountered in operations on the actively bleeding patient. The patient may have been in shock or in impending shock and for that reason may be unable to tolerate surgical intervention well. The diagnosis of the source of bleeding may not be definite. There may be multiple bleeding points in the stomach and duodenum. It may be difficult to find the bleeding point in a

TABLE 11.—*Indications for Surgical Intervention in 26 Patients with Bleeding Peptic Ulcer*

Indication	Number of Patients	Number Who Died
Emergency operation for continuing bleeding	10	5
Interval operation because of repeated bleeding	5	0
Interval operation for complications other than bleeding	11	0

blood-filled stomach, especially if it is high on the lesser curvature. Bleeding may recur postoperatively after ligation or suture of a bleeding ulcer. All these difficulties were encountered among the 26 surgically treated patients in this series.

The over-all mortality in the 26 surgically treated patients was 19.2 per cent, as compared with 11.3 per cent for the 204 medically treated patients.

In 10 patients an emergency operation during active bleeding was performed, and of these, 5 died. In 5 patients operation was performed after initial bleeding had ceased because of repeated episodes and the danger of further bleeding, and in this group there were no deaths. In 11 patients operation was performed after bleeding had ceased, chiefly because of complications other than bleeding, and in this group there were no deaths. It can be seen that an interval operation is preferable whenever possible (table 11).

In the 26 surgically treated patients the condition was much more severe and intractable than in the medically treated patients (table 12).

18. Metheney, D., and Green, D. M.: West. J. Surg. **55**:97-102, 1947. Allen,[17] Gordon-Taylor.[16]

The average age was about the same for both groups, 50 for the medically treated and 48 for the surgically treated patients. The surgically treated patients had a higher number of previous episodes of bleeding, a mean of 1.5 as compared to a mean of 0.63 for the medically treated patients. The surgically treated group had an incidence of complications of ulcer other than bleeding of 92 per cent, as compared to 30 per cent for the medically treated patients (table 13). Of the surgically treated patients, 58 per cent had continued to bleed or had recurrence of bleeding after forty-eight hours of medical treatment, whereas only

TABLE 12.—*Comparison of Clinical Data on Medically and Surgically Treated Patients with Bleeding Peptic Ulcer*

Type of Treatment	Number of Cases	Average Age	Average Number of Previous Bleeding Episodes	Incidence of Complications Other than Bleeding, Percentage	Mortality, Percentage
Medical	204	50	0.63	30	11.3
Surgical	26	48	1.5	92	19.2

TABLE 13.—*Complications Other than Bleeding in 26 Surgically Treated Patients with Peptic Ulcer*

Complication	Number of Cases	Percentage
Intractability	14	56
Obstruction	6	24
Perforation	1	4
Gastric type	6	24
Marginal type	1	4
Continuing massive hemorrhage	10	36

7 per cent of the medically treated patients showed evidence of bleeding after forty-eight hours of treatment.

Table 14 shows the types of operations performed and the results of each type. Of the patients operated on during active bleeding, 7 underwent gastric resection, with 2 deaths, 2 were subjected to suture of the ulcer and gastroenterostomy and both died from continued hemorrhage and 1 patient underwent duodenotomy and gastrotomy without the bleeding point being found. This patient continued to bleed postoperatively and died, and at autopsy a gastric ulcer was found. Among the patients operated on after active bleeding had ceased, 15 underwent gastric resection, with no deaths, and 1 underwent separation of a penetrating ulcer from the liver, suture of the opening in the stomach and gastroenterostomy. This patient also recovered.

In the 10 patients operated on during active bleeding gastric resection was more successful than attempts to control a bleeding point by suture or ligation. It would seem that a gastric resection is the operation of choice, unless the patient is too poor an operative risk.

Table 15 gives an analysis of the 5 deaths in the surgically treated patients and shows that in 3 cases death occurred from continued

TABLE 14.—*Results of Different Types of Operation in 26 Surgically Treated Patients with Peptic Ulcer*

Type of Operation	Actively Bleeding at Time of Operation		Interval Operation	
	Number of Patients	Number Who Died	Number of Patients	Number Who Died
Gastric resection	7	2	15	0
Suture of ulcer and gastroenterostomy	2	2	1	0
Duodenotomy and gastrotomy	1*	1	0	0

* No bleeding point was found. Bleeding continued postoperatively, and a gastric ulcer was found at autopsy.

TABLE 15.—*Analysis of Fatalities in Surgically Treated Patients with Bleeding Peptic Ulcer* *

Age	Time of Death: Number of Days After Admission	Time of Death: Number of Days After Operation	Type of Operation	Cause of Death	Postmortem Examination
53	8	4	Gastrotomy and duodenotomy; no bleeding point found	Massive hemorrhage; continued bleeding from gastric ulcer	Yes
24	52	5	Gastric resection	Atelectasis; transfusion reaction	No
49	29	10	Ligation of vessel in duodenal ulcer; gastroenterostomy	Continued bleeding; peritonitis from leaking suture line	Yes
51	42	3	Perforation into liver closed; gastroenterostomy	Continued bleeding	No
60	12	4	Gastric resection	Atelectasis and pneumonia	No

* Of the 5 patients who died, 3 had red blood cell counts below 1,500,000 on their admission to the hospital. In the other 2 there was a sharp drop in the red blood cell count while they were in the hospital, to 2,100,000 in 1 and to 1,600,000 in the other.

massive hemorrhage postoperatively. In 1 of these 3 patients peritonitis from a leaking suture line contributed to the fatal result. In all 3 of the patients who continued to bleed postoperatively an attempt to treat the bleeding ulcer by ligation or suture had been made. In the other 2 fatal cases postoperative complications were responsible for death. One of the 2 patients had atelectasis and a severe transfusion

reaction. The other had atelectasis and superimposed pneumonitis. The 5 deaths occurred between the third and the tenth postoperative day.

All 5 of the patients who died after surgical intervention were severely ill. Three were operated on after a week or more of medical treatment with bleeding still continuing or recurring. Three had red blood cell counts below 1,500,000 on their admission to the hospital, and the other 2 had a sudden drop in the red blood cell count in the hospital under medical treatment, i. e., in one to 2,100,000 and in the other to 1,600,000.

COMMENT

The management of patients with massive hemorrhage from the upper gastrointestinal tract presents a difficult problem, from the point of view of both diagnosis and therapy. Thus in the 305 patients of our series 11 different causes for the bleeding were encountered, and in a small group no cause was found at all. The therapeutic considerations must take into account not only the gastrointestinal tract, in which the bleeding is manifest, but also a number of extragastrointestinal factors. In elderly persons, especially, who when they have gastrointestinal bleeding present difficult problems *a priori,* other factors relating to the cardiovascular, genitourinary and pulmonary system must be strongly considered.

Intensive medical management must be started in every patient with massive bleeding from the upper part of the gastrointestinal tract. This should consist of absolute rest in bed, sedation, blood transfusions and the administration of other fluids to restore the patient's electrolyte balance and to combat dehydration and azotemia. Vitamins and antispasmodics can be given parenterally. If vomiting has ceased shortly after the patient enters the hospital, one of the many antacids may be given with the hourly milk and cream feedings.

Blood transfusions, repeatedly given if necessary, are the basis for successful treatment of bleeding ulcers. While there still exist some who object to the use of blood transfusions because they may cause further bleeding due to sudden elevation of the blood pressure, the majority of clinicians favor transfusions. Some,[19] including ourselves, advocate massive blood transfusions or rather sufficient blood to replace the amounts lost by hematemesis or melena. Others [20] recommend the

19. (*a*) Bockus, H. L.: Gastroenterology, Philadelphia, W. B. Saunders Company, 1946, vol. 1, chap. 29. (*b*) Gray, S. J.: M. Clin. N. America **31**:1121-1134, 1947. (*c*) Miller, T. G., and Elsom, K. A.: M. Clin. N. America **22**:1711-1733, 1938.

20. Crohn, B. B., and Lerner, H. H.: Am. J. Digest. Dis. **6**:15-22, 1939. Kirsner, J. B., and Palmer, W. L.: Internat. Clin. **4**:105-126, 1939. Marriott, H. L., and Kekwick, H.: Lancet **1**:977-981, 1935. Wood, I. J.: M. J. Australia **2**:1031-1038, 1937.

use of smaller transfusions. In general, we believe that the amount of blood given should be governed by the patient's need, and that, as already stated, the patient receiving blood should be carefully watched for other symptoms and signs which might indicate a possible overburdening of the cardiovascular system. When the blood is given slowly (about 4 cc. per minute) and only to patients for whom it is definitely indicated, there is little need to fear further bleeding caused by a rise in blood pressure. Blood transfusions are of value not only because they restore the patient's blood volume but also because they combat hypoproteinemia and improve his general condition.

Most clinicians believe that the treatment of choice for the great majority of patients with acute massive hemorrhage from a peptic ulcer of the stomach or duodenum is medical management. There are, however, instances in which such a hemorrhage may prove fatal unless surgical intervention is performed. Such possibilities are more likely to occur in patients over 45 or 50 years of age. We feel that for patients with peptic ulcers who continue to show evidence of active bleeding, despite intensive medical management, surgical intervention must be seriously considered at any time after their admission[21] and that it should not be delayed until the patient becomes too poor a surgical risk.[22] A similar attitude is also expressed by others,[23] but this opinion is not uniformly held.

There are, however, factors which must be weighed against the indications in each individual case. The presence of cardiac decompensation, of renal disease or of some other associated severe extragastrointestinal illness may suggest giving the medical regimen a somewhat longer trial. Similarly, marked obesity, severe hypertension and cerebral manifestations may speak against early surgical intervention. Occasionally the lack of definite knowledge of the source of bleeding will influence the decision concerning immediate operation.

SUMMARY AND CONCLUSIONS

A group of 305 patients admitted to the Cook County Hospital because of hemorrhage of the upper part of the gastrointestinal tract were studied. Data are presented concerning (*a*) the differentiation of bleeding ulcer from other causes of gastrointestinal hemorrhage; (*b*) factors influencing the course, and (*c*) factors indicating surgical intervention and results. On the basis of these data the following conclusions can be drawn:

21. Meyer, K. A., and Steigmann, F.: S. Clin. North America **24**:29-49, 1944.

22. Goldman, L.: Gross Hemorrhage from Peptic Ulcer: Its Morbidity, Mortality and Treatment, J. A. M. A. **107**:1537-1542 (Nov. 7) 1936.

23. Kruse, F. H.: Complications of Peptic Ulcer and Their Treatment, J. A. M. A. **109**:868-874 (Sept. 11) 1937. Finsterer.[15] Gray.[19b] Heuer.[14]

1. Hematemesis or melena may be produced by a variety of conditions. In making a diagnosis of the cause of bleeding careful elicitation of the history and examination are important, as are roentgenologic studies after a barium meal, gastroscopy, liver function tests, serologic studies, a search for lesions of the small bowel and a search for possible blood dyscrasias.

2. Various factors affect directly the prognosis for patients with bleeding peptic ulcer. Among these are the age of the patient, the number of previous hemorrhages, the blood count and blood pressure on admission to the hospital, the blood nonprotein nitrogen, the presence of certain symptoms such as fainting and the response to a trial of medical treatment.

3. The majority of patients with bleeding peptic ulcer can best be treated medically, and adequate amounts of blood are important in this treatment.

4. The prognosis for patients who continue to bleed actively while under an intensive medical regimen or who have a recurrence of bleeding after forty-eight hours of medical treatment is poor. In our series the mortality rate among such patients was 58 per cent on continued medical treatment as compared to 30 per cent with surgical intervention. Therefore as a group these patients seem to have a better chance with surgical treatment.

5. Surgical intervention during active bleeding from a peptic ulcer carries a high mortality and should be reserved for a small group of carefully selected patients. The chief indication is the failure of bleeding to stop within forty-eight hours under medical treatment or its recurrence during medical treatment, especially in patients over 45 years of age.

6. If the patient is not in too poor condition, a gastric resection is the operation of choice.

7. Many patients for whom the prognosis is poor because of their age or the number of previous hemorrhages or who have bled repeatedly in spite of medical treatment should be operated on between episodes of bleeding after proper preparation. The mortality rate can be kept low, and in most cases operation will prevent further hemorrhages.

RESECTION OF THE INTERVERTEBRAL DISK THROUGH THE POSTERIOR APPROACH

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IN A PREVIOUS paper it was shown that fusion of the vertebral bodies could be attained when the intervertebral disk was removed through the transabdominal approach.[1] It was predicated at that time that the same result could be obtained by removing the disk after a laminectomy from the usual posterior approach. It has been claimed by some surgeons that osseous union will be secured in patients after thorough removal of the disk through the posterior approach, although no conclusive evidence has been presented to establish it as a fact.

In order to study the results of a resection of the disk through the posterior approach, a series of experiments were performed on animals. The method employed consisted of exposing the spinous processes and the laminas of the lower lumbar vertebrae. Because of the small size of the laminas and the disk, it was necessary to remove the spinous processes to obtain sufficient exposure and room to see the disk. Furthermore the disk is small in the dog and not easily recognized through a small aperture. Seven experiments were performed on dogs at different ages, and a variable length of time was allowed to elapse before the completion of the experiment.

Dog 1 (young dog).—The duration of this experiment was one hundred and thirty-one days.

Operation.—An incision was made over the sixth and seventh lumbar spinous processes (the dog has seven lumbar vertebrae) and the muscle stripped off from the spinous processes and laminas subperiosteally. The spinous processes with the laminas on the right side were removed from two of the vertebrae. The cord and nerve roots were carefully deflected, and the posterior ligament was incised over the disk. The disk was then resected and curetted as thoroughly as possible. It is difficult or practically impossible to remove all the disk because of the small size of the exposure and the mechanical problems. A small metal marker was placed in the resected area to aid in identification in the roentgenograms after the operation. The wound was then closed in layers with silk. No protecting support was applied.

Result.—There was no motion between the sixth and seventh lumbar vertebral bodies. A slight amount of motion was seen in the articular facets on lateral

From the Surgical Laboratory, Stanford University School of Medicine.

1. Haas, S. L.: Fusion of the Vertebrae Following Resection of the Intervertebral Disc, J. Bone & Joint Surg. **28**:544-549 (July) 1946.

bending. There was some regeneration of bone in the region of the resected laminas. The disk from the anterior side showed no evidence of bone, but as the posterior surface was approached there was a bridge of bone between the two vertebral bodies. The roentgenogram in the lateral view showed a small bridge of bone on the posterior portion of the resected disk (fig. 1 *A*).

Dog 2 (old dog).—The duration of the experiment was one hundred and forty-six days.

Operation.—An incision was made over the fifth and sixth spinous processes. The laminas on the right side of the fourth and fifth lumbar vertebrae were removed, and the disk between the two was removed as thoroughly as possible. A wire marker was inserted into the disk space for identification in the roentgenogram.

Result.—There was only slight give between the bodies on forced pressure. There was no discernible motion at the articular facets. The disk operated on was then exposed, beginning from the abdominal side, and was found to be narrower than normal and replaced by fibrous tissue. The nucleus pulposus was only partly destroyed. The posterior part of the disk, toward the cord, was replaced by osseous tissue. The roentgenogram did not show the osseous bridge, but the disk space was narrower than normal.

Dog 3 (young full-grown dog).—The duration of the experiment was one hundred and forty-six days.

Operation.—The disk between the seventh lumbar vertebrae and the sacrum was exposed and destroyed as well as possible.

Result.—There was no evidence of fusion across the lumbosacral intervertebral disk. A small piece of bone projected upward from the sacrum toward the lumbosacral articulation. After the dissected disk was exposed some fibrous tissue was found between the bodies, which in some places looked like fibrocartilage. The laminas showed some evidence of regeneration. In the roentgenogram the disk space was found to be irregular and narrower than normal, but there was no evidence of bone bridging between the bodies.

Dog 4 (old dog).—The duration of the experiment was one hundred and forty-seven days.

Operation.—The disk between the seventh lumbar and first sacral segment was exposed by the same method as in the previous experiment. The disk was removed as thoroughly as possible.

Result.—There was no evidence of union or of restriction of motion. It was possible to get some motion in the anterior-posterior direction in the lumbosacral disk by force. The disk was widened anteriorly. Posteriorly there was some bone proliferation from the laminas of the first sacral segment. The roentgenogram showed no signs of new bone in the disk space. The disk was broader anteriorly than normal.

Dog 5 (young growing dog).—The duration of the experiment was one hundred and twenty-five days.

Operation.—The disk between the fifth and sixth lumbar vertebrae was resected and then curetted.

Result.—The laminas showed considerable evidence of regeneration. There was no motion between the fifth and sixth lumbar bodies or articular facets. The disk space was narrow, and when the area of operation was exposed, there was new bone and cartilage connecting the two bodies posteriorly. The nucleus pul-

posus was found intact. The roentgenogram shows a thin bridging with bone on the posterior side. The disk between the sixth and seventh vertebrae is thinner than normal.

Dog 6 (young growing animal).—The duration of the experiment was eighty-nine days.

Operation.—After the disk was exposed between the sixth and seventh lumbar bodies, it was removed by excision and curetted as thoroughly as possible.

Result.—There was no evidence of fixation between the two bodies. The intervertebral space was filled with soft tissue, and on manipulation there was abnormal mobility.

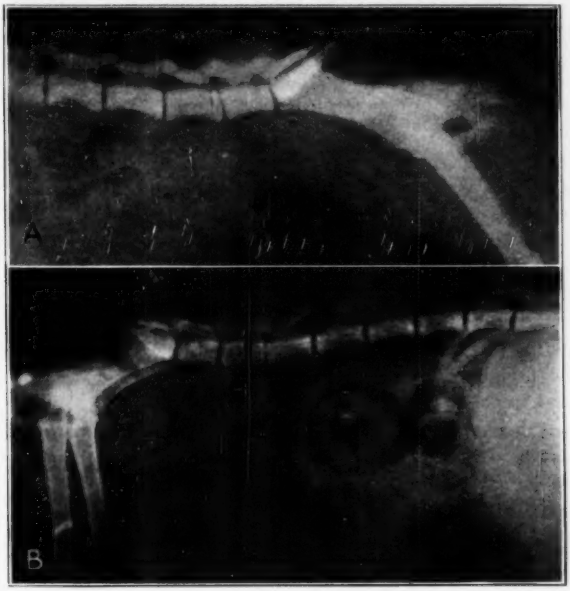

Fig. 1.—*A*, dog 1. Narrow bridge of bone on posterior portion of disk. Wire marker inserted at the time of operation. *B*, dog 8. Osseous bridge between the two vertebrae. Marker at the site of disk operated on.

There was no evidence of bone proliferation in the roentgenogram. The disk space was narrower than normal.

Dog 8 (young growing dog).—The duration of the experiment was one hundred and thirty-one days.

Operation.—The disk between the fifth and sixth lumbar vertebral bodies was exposed and cleaned out with a curet.

Result.—Good fixation was found between the fifth and sixth lumbar vertebral bodies. There was no motion between the articular facets. When a series of cuts beginning on the anterior surface were made, the anterior half of the disk was found to be replaced by fibrous tissue. About half way through an osseous

bridge was encountered extending across the intervertebral space. The laminas had partially regenerated.

The roentgenogram (fig. 1 *B*) showed a bone bridge on the posterior portion of the disk. The remainder of the disk was narrower than normal. In studying the series of roentgenograms after the operation, it was noticed that bone was not discernible until about four months postoperatively.

COMMENT

An osseous bridge of bone was found on the posterior or cord side of the intervertebral disk after resection. In none of the experiments was the disk entirely replaced by bone. The failure of complete union is due to the inability to remove sufficient disk tissue so as to expose bone on both vertebral bodies. This is more easily accomplished by the anterior or abdominal approach; in experiments using this approach a complete osseous bridge formed between the vertebral bodies after resection of the disk.

In several experiments there was evidence of degenerative changes after attempted resection of the disk, with increased mobility between the vertebral bodies. The failure of bone production may be due to poor regenerative powers of the bone in old animals or a failure to expose sufficient bone.

It was noticed that in the old animals there was little new bone in the intervertebral space and in most animals no new bone was found.

A period of four months was necessary after resection to be able to see bone bridging between the vertebral bodies. In no case was the entire disk replaced with bone.

When there was a bridge of bone between the bodies, firm fixation took place between them and there was no motion in the joints between the articular facets.

There was evidence of bone regeneration in the laminas after laminectomy.

SUMMARY

In young animals an osseous bridge was obtained between the vertebral bodies after resection of the disk by the posterior route. In no case was there a complete replacement of the disk by bone.

In old animals bone proliferation was slight. In some animals there was increased mobility at the site of the resected intervertebral disk.

An elapse of about four months was necessary before bone bridging could be seen in the roentgenogram.

GIANT NEVUS OF THE BACK

Treated by Complete Excision and Skin Grafting

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GIANT moles or nevi are relatively uncommon. They are, however, generally reported as medical curiosities since, until relatively recently, they have been considered beyond the scope of ordinary treatment.

As far as I am aware, the nevus in the back to be described is one of the largest which has been excised and to have the defect closed by grafts in multiple stages.

A good review of the literature was given by Pickrell and Clay.[1] They also described a case of giant nevus of the thigh in a white boy aged 6 years treated by excision and immediate replacement by split-skin grafts taken from the back and the opposite thigh by means of a Padgett dermatome.

The nevus in their case measured 19 by 10 inches (48 by 25 cm.), and they described it as being the largest nevus to be excised, and to have the defect covered by skin grafts, in either single or multiple stages.

The case to be described is one in which an enormous pigmented hair-bearing nevus measuring 18 by 14 inches (45 by 35 cm.) was excised and the defect covered with grafts. The operation was done in three stages.

REPORT OF A CASE

Mr. B., a white man aged 32, was seen in February 1944. He presented the enormous nevus on his back, the measurements being 18 inches vertically and 14 inches horizontally (fig. 1 *A*). This had been present since birth.

It was interesting to note that this man had been with the forces in North Africa and Italy but on no single occasion had he exposed his back in the company of his friends such as in shower baths, sea bathing in the Mediterranean or sun bathing. He was intensely shy and introspective and would hardly submit to a medical examination.

The patient was physically well. The affected area on the back was covered by a black, hairy nevus, raised in parts into verrucous and horny elevations.

First Operation.—On Feb. 16, 1944, about half the nevus was excised. In spite of good and quick hemostasis and the use of a drip blood transfusion, the anesthetist reported that the patient would not stand removal of the whole area.

Second Operation.—On February 24, strips of Thiersch graft were applied on the granulating area.

From the Department of Surgery, University of Pretoria.

1. Pickrell, K. L., and Clay, R. C.: Giant Nevus of the Thigh Successfully Treated by Complete Excision and Primary Grafting, Arch. Surg. **48**:319-324 (April) 1944.

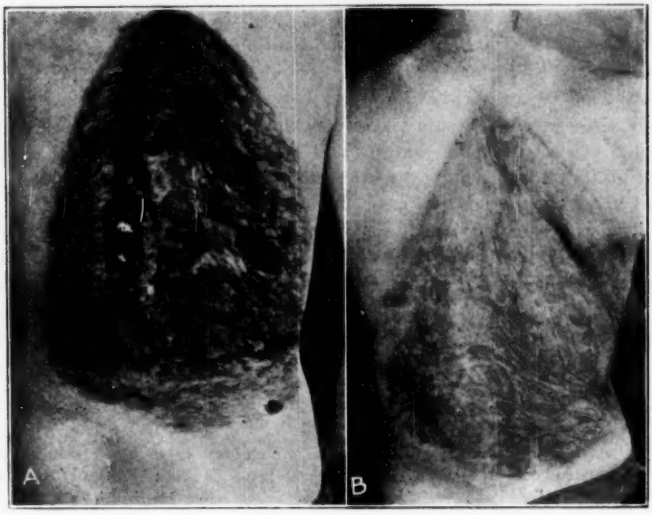
Third Operation.—On March 24 the rest of the nevus was removed and strip Thiersch grafts were applied to the remaining raw area.

Healing occurred rapidly, and this was followed by a course of oil massage.

About one-half inch (1.27 cm.) of normal skin was removed beyond the edge of the nevus, leaving a raw area of over 280 square inches (1,692 sq. cm.) to cover.

The patient was seen in June 1945, when a photograph (fig. 1*B*) showed complete healing, the area being covered by soft, pliable skin, now freely movable over the underlying deep fascia. He was a changed man psychologically.

A letter from him dated May 7, 1948, states that he is perfectly well, that his back has not troubled him at all, that he has married and that he has a bonny daughter, who does not have a "birthmark."



A, enormous nevus, present since birth; *B*, complete healing after excision and skin grafting.

SUMMARY

A giant nevus, measuring 18 by 14 inches (45 by 35 cm.) is described. The nevus was totally excised and the defect covered by Thiersch grafts.

Until relatively recently giant nevi have been considered medical curiosities, but it is advocated that these lesions should be excised and the defect grafted, in a single stage procedure as in the case of Pickrell and Clay [1] or in a multiple stage procedure as in the case described here.

I would suggest that the multiple stage procedure with strip Thiersch grafts be employed, as a large raw area can be covered with a relatively small piece of skin. Removal of numerous drums of skin from the body with a dermatome is liable to leave marked visible discolorations.

ROLE OF THE TRANSVERSE ABDOMINAL INCISION AND EARLY AMBULATION IN THE REDUCTION OF POSTOPERATIVE COMPLICATIONS

JAMES B. THOMPSON, M.D.
KENNETH F. MacLEAN, M.D.
AND
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THE PROBLEM of how best to approach the peritoneal cavity with a minimum of postoperative complications has challenged the attention and acumen of surgeons for many years. One may consult the references given in this paper for a review of the work of the many who have contributed to this problem of the proper abdominal incision [1] and the concepts of early ambulation.[2]

The purpose of this paper is to review briefly the fundamental anatomic and physiologic principles and to tabulate the clinical results which have led us to use routinely the transverse abdominal incision as well as to emphasize early ambulation increasingly.

Langer's lines of skin cleavage are situated transversely; hence, an incision which parallels them will close with less tension and leave a finer scar when it heals.

The oblique muscles originate laterally and, becoming aponeurotic, pass in an essentially transverse direction to insert into the linea alba, having formed the anterior and posterior rectus sheaths.[3] The external and internal oblique muscles practically never vary more than 30 degrees from the transverse plane,[1] while the transversus abdominis is truly transverse. If the aponeurotic fibers are visualized as multiple small tendons,[4] it is apparent that a vertical incision divides them at right angles to their courses while a transverse incision tends to

From the Department of Surgery, University of Michigan Medical School.

1. Rees, V. L., and Coller, F. A.: Anatomic and Clinical Study of the Transverse Abdominal Incision, Arch. Surg. **47**:136-146 (Aug.) 1943.

2. Leithauser, D. J.: Confinement to Bed for Only Twenty-Four Hours After Operation, Arch. Surg. **47**:203-215 (Aug.) 1943.

3. McVay, C. B., and Anson, B. J.: The Composition of the Rectus Sheath, Anat. Rec. **77**:213-225 (June 25) 1940.

4. Moschowitz, A. V.: Transverse Incisions in the Upper Abdomen, Ann. Surg. **64**:268-287 (Sept.) 1916.

parallel their courses. Incision of the aponeuroses transversely is less traumatizing and therefore the more sound procedure physiologically. The intact fibers adjacent to the transverse incision provide firmer anchorage for suture material than do the cut ends of fibers presenting at the margins of the vertical incision.

The rectus abdominis passes vertically from the pubes to the xiphoid process and the adjacent ribs. The muscle is narrow below and broad above, occasionally approaching the anterior axillary line laterally.[1] Three equally spaced tendinous inscriptions firmly attach the muscle to the anterior rectus sheath, above the level of the umbilicus. Occasionally four or more are present, and the additional ones are equally spaced below the umbilicus. These inscriptions allow minimal retraction of the transected muscle, making for accurate approximation with simple suture of the sheaths. Below the umbilicus firm healing follows suture of the anterior sheath, as demonstrated repeatedly at reoperation.

The oblique muscles provide protection and play a major role in altering intra-abdominal pressure, so closely related to respiration and therefore of prime concern postoperatively.

The lower six intercostal and first lumbar nerves supply the abdominal wall (fig. 1). All pass in an essentially transverse direction, anastomose richly in the wall and terminate in the recti, where anastomoses are deficient.[1] The transverse incision tends to parallel their courses and provides opportunity for their visualization, thereby reducing traumatization. The vertical incision is prone to sever or contuse them, giving rise to pain and splinting as a result of hyperirritability. Painful scars due to neuromas[5] and atrophy of the muscle segments involved are possible late results of such trauma.

The blood supply of the abdominal wall is derived largely from the superior and inferior epigastric vessels. The vertical incision is parallel to them and thus spares them, while the transverse incision in the upper and lower quadrants cuts across them. Anastomoses are rich enough, however, to assure tissue viability.

Since the oblique muscles with their aponeuroses hold the major role, in so far as the anterior abdominal wall is concerned, in altering intra-abdominal pressure, they become an integral part of the respiratory mechanism. Deep breathing and coughing,[6] essential in the prevention and treatment of postoperative pulmonary complications, are facilitated by the strong contracture of these muscles. Interference with this action jeopardizes the efficient performance of these respiratory acts. The resultant of forces on contracture of the oblique muscles is in the trans-

5. Bancroft, F. W.: Painful Postoperative Abdominal Scars, Arch. Surg. **21**:289-299 (Aug.) 1930.

6. Haight, C., and Ransom, H. K.: Observations on the Prevention of Atelectasis and Bronchopneumonia, Ann. Surg. **114**:243-262 (Aug.) 1941.

verse plane; hence, it is true that the vertical incision will have greater stress placed on it during the respiratory cycle than will the transverse. Sloan [7] emphasized this by measuring, in 20 different patients, the force needed to approximate the edges of an L-shaped incision while the patient was under light general anesthesia. In every case he found that the force required to approximate the vertical limb was about thirty times greater than that necessary to approximate the transverse limb.

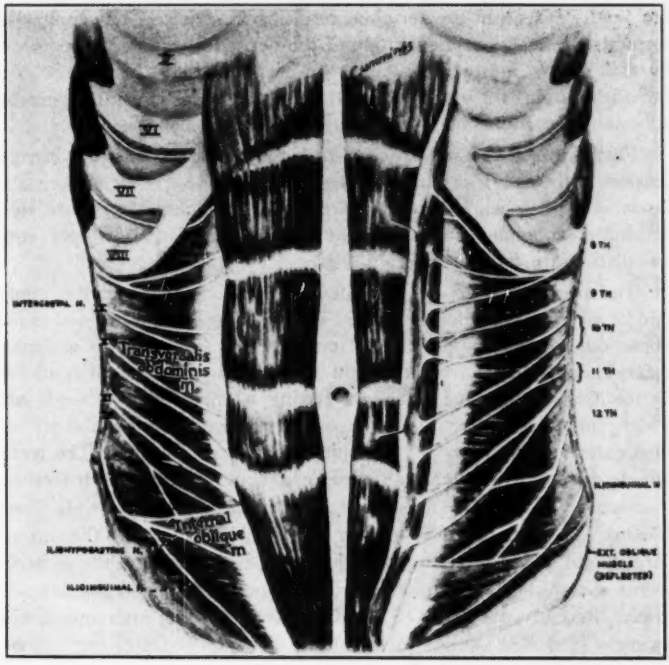

Fig. 1.—The courses of the intercostal nerves and their anastomoses. The tendinous inscriptions, which attach the rectus muscle to its anterior sheath, are shown. (From Rees, V. L., and Coller, F. A.: Arch. Surg. **47**:136-146 [Aug.] 1943.)

One of the consequences of this increased stress is less efficient respiration with reduction in vital capacity, which may be as much as 58 per cent below normal, according to Beecher.[8] With these facts in

7. Sloan, G. A.: A New Upper Abdominal Incision, Surg., Gynec. & Obst. **45**:678-687 (Nov.) 1927.

8. Beecher, H. K.: The Measured Effect of Laparotomy on the Respiration, J. Clin. Investigation **12**:639-650 (July) 1933.

mind one may state that the transverse incision will give rise to far less interference with the respiratory mechanism than will the vertical incision.

The peritoneum, being closely adherent to the transversalis fascia and thus to the posterior rectus sheath (above the umbilicus), is subjected to the stresses of those structures, as all usually are closed in one layer. As the vertical incision is subjected to far greater stress than is the transverse incision, so will it be reflected in the peritoneal suture line, with consequent greater pain, resulting in splinting and diminished respiratory excursion. Separation of the peritoneal suture line preceded by that in the transversalis fascia or posterior rectus sheath or both provides a nidus for wound disruption, adherence of bowel or, later on, adhesions. Incisional hernia may have its start in such a process.

Pain is minimal in the patient with the transverse incision because tension on the skin is lessened, nerves are preserved and the aponeurotic, fascial and peritoneal suture lines are under less stress. Therefore, deep breathing, coughing, moving about in bed, bed exercises and early ambulation are facilitated.

The transverse incision provides excellent exposure in the upper, middle or lower quadrants and is used exclusively for all abdominal operations at this hospital. All incisions are fashioned in a similar manner. Each layer from the skin through the peritoneum is incised in the transverse plane. Patients having a narrow costal angle and undergoing total gastrectomy or vagotomy frequently require a short vertical extension of the upper abdominal, transverse incision. The rectus muscle is partially or totally divided, or as in gastrectomy, both recti are transected. The oblique muscles are split in the direction of their fibers. Closure is accomplished by means of a double strand of 000 chromic surgical gut used as a running stitch in the peritoneum and the posterior rectus sheath, below the umbilicus in the peritoneum and transversalis fascia. Recently one of us (F. A. C.) has been using interrupted, fine, stainless steel wire sutures for this layer. The aponeuroses and anterior rectus sheaths are closed with interrupted silk or wire sutures. During the latter half of the period covered by this study the layers were closed almost exclusively with stainless steel wire, size 32. The subcutaneous tissue is closed with a running strand of wire singly or in tiers, depending on the thickness of the panniculus. The skin is closed by means of a continuous subcuticular strand of wire (fig. 2). The cutaneous and subcutaneous sutures are removed on the seventh postoperative day. No suture material remains in the subcutaneous tissue, and there are no sutures placed in the rectus muscle. Silk was substituted for wire in the skin and subcutaneous tissue in about 30 per cent of the cases covered by this study. No retention sutures of any type are used.

Wire is the suture material of choice for abdominal wounds, not because of its strength but because it incites measurably less inflammatory reaction than any other material. This fact has been proved by experimentation on animals and has been observed clinically. Fine silk is used for ligatures.

In cases of contamination, such as peritoneal soiling during an anastomosis or an abscess adjacent to a slowly perforating carcinoma, the delayed primary closure technic is carried out. This closure is exactly like that previously described up to the subcutaneous layer.

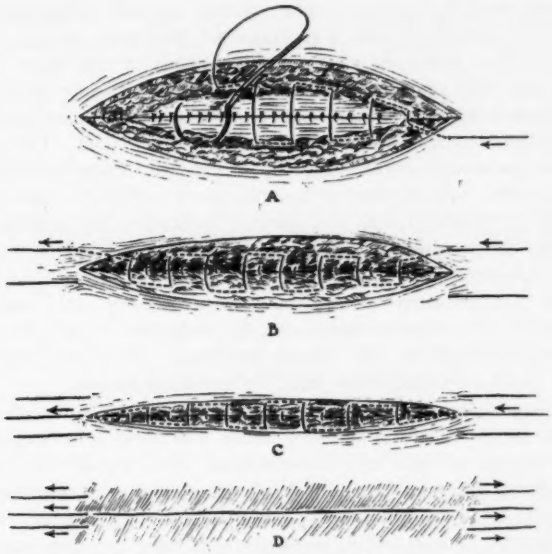

Fig. 2.—Our method of closing the subcutaneous tissue and skin with stainless steel wire. *A*, the first layer is subcutaneous fat. *B*, when necessary a second suture is made in the same layer. *C*, subcuticular wire suture. All sutures in these layers are removed on the seventh postoperative day, leaving no foreign material in the skin or subcutaneous tissue.

The skin and the subcutaneous tissue are not approximated; however, figure-of-8 silk sutures are placed. A suitable loose pack holds the skin edges apart for forty-eight hours, at which time the wound is inspected, and if uninfected it is closed by tying the previously placed silk sutures.

The vertical incisions used were of the standard type, and closure was obtained by the use of fine, chromic surgical gut for the peritoneum–posterior rectus sheath layer and wire or silk for the aponeuroses and for the skin.

In order to determine the results of the use of the transverse incision and early ambulation as compared to the vertical incision and late ambulation, 1,363 consecutive operative cases were reviewed. The numerical details concerning type of incision and ambulation are shown in the tables.

All operative procedures were intraperitoneal and all were major, herniorrhaphy or appendectomy not being included. The operations were carried out by various members of the general surgical staff of the University Hospital. Factors other than type of incision and time of ambulation were as nearly similar as it is possible for them to be.

There were 616 (45 per cent) patients who had malignant disease of the gastrointestinal tract. Eight hundred and eighty (65 per cent) of the operative procedures were on the stomach or the large or small bowel, and the vast majority were resections of some type. Four hundred and forty-four operations (32 per cent) were on the biliary system, 161 including an attack on the common duct. The patients were, as one would expect in a group 45 per cent of whom had a malignant condition, over 50 years of age, with many past 60. No case in which drainage of infection was the primary indication for operation was included. All wounds were closed primarily or by the technic of delayed primary closure.

The data tabulated for each case are as follows: (1) number of postoperative days in the hospital, (2) pulmonary complications, (3) vascular complications, (4) wound infections, (5) wound disruption, (6) postoperative obstruction and (7) incisional hernia.

Table 1 shows the average postoperative stay in the hospital. This table is set up exactly as those to follow and needs some explanation. The T column indicates transverse incision, with early and late ambulation included. Columns E. A. and L. A. denote early and late ambulation with both types of incisions included under each. Column T. E. A. includes those patients having a transverse incision in whom ambulation was carried out early, while column V. E. A. indicates early ambulation for those patients with a vertical incision. The last two columns (T. L. A. and V. L. A.) compare transverse and vertical incisions, ambulation having been carried out late in all the patients. The bottom row of figures indicates the total number of cases included in each category; thus, in 523 patients a transverse incision and early ambulation were employed, while in 412 vertical incisions were used and ambulation was carried out late.

Early ambulation, so far as this report is concerned, means that the patient is out of bed and moving about periodically and progressively from the first twenty-four postoperative hours.

Table 1 demonstrates that the use of transverse incision plus early ambulation results in the shortest postoperative stay in the hospital,

sixteen days. The use of the vertical incision with late ambulation results in the longest stay, twenty-three days.

Table 2 gives the number and percentage of pulmonary complications for each category. The pulmonary complications included infarcts, patchy or massive atelectasis and pneumonia. All diagnoses were made clinically and confirmed roentgenologically and/or bronchoscopically. Transverse incision plus early ambulation gave the lowest rate of pulmonary complications, while vertical incision plus late ambulation gave the highest, 3 per cent and 11 per cent, respectively. Vertical incision with early ambulation, although used in a comparatively small group (191 cases), gave 7 per cent pulmonary complications, as compared with 3 per cent for transverse incision with early ambulation. Transverse incisions plus

TABLE 1.—*Postoperative Stay in the Hospital*

	T*	V	E.A.	L.A.	T.E.A.	V.E.A.	T.L.A.	V.L.A.
Postoperative hospital days	17	20	17	20	16	17	17	23
Total cases	760	602	714	649	523	191	237	412

* T indicates transverse incision; V, vertical incision; E.A., early ambulation; L.A., late ambulation; T.E.A., transverse incision with early ambulation; V.E.A., vertical incision with early ambulation; T.L.A., transverse incision with late ambulation, and V.L.A., vertical incision with late ambulation.

TABLE 2.—*Pulmonary Complications*

	T	V	E.A.	L.A.	T.E.A.	V.E.A.	T.L.A.	V.L.A.
Pulmonary complications	29	57	27	59	12	14	16	43
	4%	10%	4%	9%	3%	7%	7%	11%
Total cases	760	602	714	649	523	191	237	412

early and late ambulation were compared with transverse incisions plus early ambulation, and the former gave 4 per cent pulmonary complications as compared with 3 per cent for the latter. Transverse and vertical incisions were compared and the former has 4 per cent pulmonary complications as compared with 10 per cent for the latter. A similar comparison between early and late ambulation shows 4 per cent for the former and 9 per cent for the latter.

Table 3 depicts the results for vascular complications. The complications considered were phlebothrombosis and thrombophlebitis. Diagnoses were made clinically and in most cases confirmed by observing the clot at the time of venous ligation. There is little of statistical significance here except for the comparison between columns T. E. A. and V. E. A., indicating a 2 per cent difference in favor of the transverse incision in the rate of vascular complications when ambulation was a constant factor.

Table 4 is a record of the rate of wound infection. The rate of infection is high. That the infections were mild is indicated by the fact that the average postoperative stay in the hospital was increased only three to four days. One should recall also that we are dealing here with an elderly group whose general nutrition is not of the best (45 per cent of the 1,363 patients had malignant disease of the gastrointestinal tract). The procedures were all of considerable magnitude and were, in the main, carried out by the resident staff, both factors tending to make the operating time fairly lengthy. The transverse incision has a rate of wound infection of 3 per cent, as compared to 6 per cent for the vertical

TABLE 3.—*Vascular Complications*

	T	V	E.A.	L.A.	T.E.A.	V.E.A.	T.L.A.	V.L.A.
Vascular complications	14	18	17	15	10	7	4	11
	2%	3%	2%	2%	2%	4%	2%	3%
Total cases	760	603	714	649	523	191	237	412

TABLE 4.—*Incidence of Wound Infection*

	T	V	E.A.	L.A.	T.E.A.	V.E.A.	T.L.A.	V.L.A.
Wound infections	19	33	25	27	14	11	5	22
	3%	6%	4%	4%	3%	6%	2%	6%
Total cases	760	603	714	649	523	191	237	412

TABLE 5.—*Incidence of Wound Disruption*

	T	V	E.A.	L.A.	T.E.A.	V.E.A.	T.L.A.	V.L.A.
Wound disruption	4	14	10	8	3	7	1	7
	0.5%	2.5%	1.5%	1.0%	0.5%	3.5%	0.4%	1.5%
Total cases	760	603	714	649	523	191	237	412

incision. Ambulation plays no part here as shown by comparing columns E. A. with L. A., T. E. A. with T. L. A. and V. E. A. with V. L. A.

Table 5 shows the rate of wound disruption. The rate of evisceration is appreciably increased when early ambulation is carried out by the patient who has a vertical incision. (Compare columns V. E. A. and V. L. A.) The rate of disruption varies only slightly when the transverse incision is used, whether ambulation is carried out early or late. (Compare columns T. E. A. and T. L. A.) Seventy-five per cent of the eviscerations of transverse incisions occurred in infected wounds, while 64 per cent of the disruptions of vertical incisions occurred in infected wounds. These figures indicate that more clean vertical wounds disrupt than is the case with clean transverse wounds and that infection is a large factor in disruption of incisions.

Table 6 deals with postoperative obstruction. Mechanical obstruction occurring during the early postoperative period is considered. In each case operation was required to relieve the obstruction, and only obstructions which resulted from incisional defects are included. The complication is infrequent in this group, being present nine times, an incidence of 0.7 per cent in 1,363 cases. The figures reveal that the patients with transverse incisions for whom ambulation was carried out early have a lower incidence of mechanical obstruction except for those for whom vertical incision plus early ambulation was used, and that is a comparatively small group. (Compare column T with V, E. A. with L. A. and T. E. A. with V. L. A.)

In the consideration of incisional hernia a follow-up report covering at least eighteen postoperative months was required. Three hundred and

TABLE 6.—*Postoperative Obstruction*

	T	V	E.A.	L.A.	T.E.A.	V.E.A.	T.L.A.	V.L.A.
Postoperative obstruction.....	2 0.3%	7 1.3%	2 0.3%	7 1.0%	2 0.9%	0 ..	0 ..	7 1.9%
Total cases.....	760	608	714	649	523	191	237	413

TABLE 7.—*Incidence of Incisional Hernia*

	T	V	E.A.	L.A.	T.E.A.	V.E.A.	T.L.A.	V.L.A.
Incisional hernia.....	7 1.3%	16 3.2%	7 1.3%	16 3.1%	4 1.0%	3 1.9%	3 1.7%	13 4%
Total cases.....	552	499	537	514	374	155	178	344

twelve cases were excluded because of inadequate follow-up. When examining the figures in table 7 one must recall that we are dealing with an elderly group in which there was a high incidence (45 per cent) of malignant disease. The lowest incidence of incisional hernia occurred in patients for whom the transverse incision combined with early ambulation was used (1 per cent). The highest incidence was in those for whom the vertical incision plus late ambulation was employed (4 per cent). Infection had been present in about one half of the incisions in which hernia later developed, this being true for both the transverse (3 of 7 hernias) and the vertical incisions (7 of 16 hernias).

COMMENT

In an attempt to determine the relative importance of the transverse incision and early ambulation in the reduction of postoperative complications the foregoing tables were made for comparison. A perusal of table 1 seems to point to the fact that the type of incision and the time of ambulation play about an equal role in reducing the postoperative

days in the hospital, the shortest average stay being recorded for the transverse incision combined with early ambulation.

Pulmonary complications, as the statistics show (table 2), are influenced about equally by early ambulation and the transverse incision. It is felt that the transverse incision with wire suture material makes the patient more comfortable and therefore early ambulation is carried out more willingly and more efficiently. Patients who cannot be ambulatory until late in the forty-eight hour period or later are able to breathe deeply, cough and carry out bed exercises with a facility not observed in patients in whom a vertical incision has been made.

Vascular complications are influenced somewhat more by the transverse incision than by early ambulation, as shown in table 3. This is a reflection of the same factors as those mentioned before concerning reduction of pulmonary complications.

The incidence of wound infection is lower when the transverse incision is used than when the vertical incision is used, ambulation having practically no influence (table 4). Devitalization of tissue due to increased tension required to close the vertical wound is a possible explanation for the higher rate of infection.

The value of the transverse incision is well illustrated in the consideration of evisceration. Wound disruption is more frequent in patients who are ambulatory early (table 5). When the vertical incision is used, early ambulation results in an incidence of disruption of 3.5 per cent. When the transverse incision is employed the incidence with early ambulation is 0.5 per cent.

The generally improved tonus of the patient who is ambulatory early would tend to decrease the over-all incidence of postoperative obstruction. Factors which cause mechanical obstruction have less opportunity to become prominent when the transverse incision is used instead of the vertical one, as borne out by the reduced incidence of that complication with the use of the former (table 6).

The transverse incision is responsible for the reduction in the incidence of incisional hernia. This has been a common observation in any comparison between the two incisions and is a reflection of the anatomic and physiologic factors discussed earlier.

Two objections to the transverse incision often mentioned are consumption of time and lack of ease of extension up or down. It is true that the transverse incision does take somewhat longer to fashion, but frequently this time is made up because of ease of closure of this incision as compared to the vertical one. Lightening of the anesthesia, with consequent tightening of the abdominal musculature, does not interfere with the closure of the transverse wound to the degree noted with the vertical incision. Modern methods of diagnosis infrequently leave doubt as to the location of the pathologic process, and therefore the

location of the incision can be decided on with the assurance that in only a small number of cases will revision be necessary. It is generally better to close the original transverse incision and make a new one than to attempt revision of the original incision.

We have observed no complication which could be attributed to transection of one or both rectus muscles.

CONCLUSIONS

1. The transverse incision is the most sound surgical approach physiologically to the peritoneal cavity.

2. Deep breathing, coughing, moving about in bed and bed exercises are carried out with less discomfort and more efficiency by patients in whom the transverse incision has been used.

3. Early ambulation is accomplished with more abandon and less discomfort and is accompanied with a far lower incidence of wound disruption when the transverse incision is used instead of the vertical one.

4. The transverse abdominal incision used in combination with early ambulation lowers the incidence of all postoperative complications studied in this series of cases and results, therefore, in a reduction in the number of postoperative days in the hospital.

MANAGEMENT OF CANCER OF THE LOWER PART OF THE BOWEL

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THE IMPORTANCE of cancer of the lower part of the bowel cannot be overemphasized when one considers that it still remains the fourth most common malignant process involving the human organism; of those of the gastrointestinal tract, it is second in frequency to cancer of the stomach. In this discussion it is our purpose to consider the preparation of the patient, choice of operative procedure and postoperative treatment, with particular reference paid to the technic of abdominoperineal proctosigmoidectomy without colostomy and preservation of the sphincter musculature.

Advances in management of cancer of the lower part of the bowel have diminished markedly the mortality rate accompanying operative procedures undertaken for this disease. This is well demonstrated in our own series of cases, which includes 640 patients with malignant growths of the anus, rectum and sigmoid colon, shown in table 1.

PREOPERATIVE EVALUATION AND PREPARATION

In order to prepare patients with any degree of adequacy for a major operation on the colon and rectum, it is essential that they be hospitalized for a period of several days. During this time, an effort is made to evaluate the patient as a surgical risk and, in so far as it is possible, ensure the optimal nutritional, fluid, electrolyte, nitrogenous and vitamin balance. The studies enumerated in the outline have been of definite value in the evaluation of our patients preoperatively.

The presence of hepatic dysfunction was noted by Abels [1] in 25 per cent of patients with malignant growths of the gastrointestinal tract. On a small scale, similar studies were undertaken in our department,

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Read before the Sectional Meeting of the Nebraska Chapter of the International College of Surgeons, Lincoln, Neb., May 22, 1947.

1. Abels, J. C.; Rebers, P. E.; Binkley, G. E.; Pack, G. F., and Rhoads, C. P.: Metabolic Studies in Patients with Cancer of the Gastrointestinal Tract: II. Hepatic Dysfunction, Am. J. Med. **16**:221, 1942.

Studies for Evaluating Patients Preoperatively

Routine	Elective
1. Complete blood count, hemoglobin and hematocrit value	1. Liver Function (*a*) Sulfobromophthalein (*b*) Cephalin flocculation (*c*) Thymol turbidity (*d*) Prothrombin time (*e*) Alkaline serum phosphatase
2. Daily specific gravity of urine	2. In cases of obstruction, ulcerative colitis or dehydration (*a*) Carbon dioxide content (or blood p_H) (*b*) Blood chlorides (*c*) Blood sodium and potassium
3. 2,500 to 3,500 cc. intake	3. Barium enema (in absence of obstruction) to demonstrate presence of other lesions
4. Serum protein with albumin-globulin ratio	
5. Blood urea, fasting blood sugar	
6. Weight in kilograms (daily)	
7. Daily fluid intake and output	
8. Medical and urologic consultation (including electrocardiographic and cystometric studies)	
9. Blood type and Rh factor	
10. Daily blood pressure	
11. Photofluorogram of chest	

but confirmation of such definite evidence of dysfunction was not demonstrable. It was interesting to note that, contrary to previous reports,[2] the alkaline serum phosphatase reaction was normal in 10 patients

TABLE 1.—*Cancer of the Anus, Rectum and Sigmoid*

Number of patients		640		
Number operated on		579		
Operability rate		90.4%		
Number in whom resection was done		514		
Resectability rate		80.3%		
		Cases	Deaths	Percentage
Abdominoperineal proctosigmoidectomy	After Babcock	344	17	4.9
Abdominoperineal excision—one stage	Miles	67	3	4.4
Abdominoperineal excision—two stage	Lahey	6	1	16.6
Sigmoidectomy—multiple stage	Mikulicz-Rankin	32	3	9.3
Sigmoidectomy—single stage	Open or closed	28	2	7.1
Perineal excision with colostomy	Lockhart-Mummery	22	1	4.5
Anterior resection	Hartmann	11	0	0
Perineoabdominal resection	Gabriel-Turner	2	0	0
Perineal excision	Cuneo-Seneque	2	0	0
Total		514	27	5.2

with massive metastasis to the liver. Occasionally, definite evidence of hepatic dysfunction has been demonstrated by the sulfobromophthalein or cephalin flocculation test. This almost invariably occurs in patients who are anemic, hypoproteinemic, malnourished and clinically poor risks. Consequently, for this group of patients varied liver function tests are ordered. When evidence of dysfunction exists, the operation is delayed until an attempt has been made to remedy the condition.

Anemia and hypoproteinemia, when present, are corrected immediately with whole blood, plasma and a high protein intake in order to provide an erythrocyte count of 4,500,000 with a concomitant hemoglobin value of 80 to 90 per cent, hematocrit readings of 40 or above and normal serum protein values. Determination of the p_H factor is routine.

2. Bullard, R. W.: Alkaline Phosphates and Metastatic Liver Disease, Surgery **19**:379, 1946.

The skin is prepared for three days preoperatively. A new substance, "G-11," used experimentally by Seastone,[3] holds promise as an effective agent for preoperative preparation of the abdominal skin. A fluid intake of 2,500 to 3,000 cc. is maintained. In order to prevent shock and maintain a positive nitrogen balance with greater ease postoperatively, 1,000 cc. of blood is made available for each abdominoperineal resection. One will recall the recent investigations of Pack[4] and Coller[5] demonstrating the loss of blood as varying from 250 to 900 cc. during this procedure.

NUTRITION

The presence of avitaminosis and malnutrition, particularly hypoproteinemia, has been demonstrated consistently in patients with malignant growths of the gastrointestinal tract.[6] It is necessary, therefore, to furnish these patients with a well balanced, high protein, high caloric, high vitamin diet which yields no residue but contains adequate amounts of both minerals and vitamins.

PROTEIN NUTRITION

Research along nutritional lines has largely been devoted to the study of protein metabolism.[7] As a result, it is now an established fact

3. Seastone, C. V.: Observations on the Use of G-11 in the Surgical Scrub, Surg., Gynec. & Obst. **84**:355, 1947.

4. Pack, G. E.; Oppenheim, A.; Abels, J. C., and Rhoads, C. P.: Estimation and Significance of Blood Loss During Gastrointestinal Surgery, A. J. Surg. **119**: 871, 1944.

5. Coller, F. A., and Crook, C. E.: Blood Loss in Surgical Operations, J. A. M. A. **126**:1 (Sept. 2) 1944.

6. Binkley, G. E.; Abels, J. C., and Rhoads, C. P.: The Treatment of Postoperative Hypoproteinemia in Patients with Cancer of the Colon and Rectum, Ann. Surg. **118**:366, 1943. Abels, J. C.; Rebers, P. E.; Pack, G. E., and Rhoads, C. P.: Metabolic Studies in Patients with Cancer of the Gastrointestinal Tract, Ann. Surg. **118**:366, 1943. Meyer, K. A., and Kozoll, D. D.: Protein Deficiency in Surgical Patients, Surg., Gynec. & Obst. **78**:181, 1944. Bacon, H. E.; Todhunter, W. D.; Gass, O., and Wolfe, F. D.: The Preoperative and Postoperative Treatment of Cancer of the Rectum and Pelvic Colon, J. Internat. Coll. Surgeons **8**:20, 1945.

7. Elmen, R., and Lischer, C.: The Occurrence and Correction of Hypoproteinemia in Surgical Patients, Surg., Gynec. & Obst. **76**:503, 1943. Mulholland, J. H.; Co Tui, F.; Wright, A. M.; Vinci, V. G., and Shafiroff, B.: Protein Metabolism and Bedsores, Ann. Surg. **118**:1015, 1943. Thompson, W. D.; Ravdin, I. S., and Frank, J. L.: Effect of Hypoproteinemia on Wound Disruption, Arch. Surg. **36**:500 (March) 1938. Rhoads, C. P.; Fliegelman, W. I., and Panzer, L. M.: Mechanism of Delayed Wound Healing, J. A. M. A. **118**:21 (Jan. 3) 1942. Jones, C. M.: Protein Deficiency, New England J. Med. **215**:1152, 1936. Best, C. H., and Taylor, W. A.: Physiological Basis of Medical Practice, Baltimore, Williams & Wilkins Company, 1945. Elman, R.: The Practical Use of Amino Acids in Protein Nutrition, J. A. M. A. **128**:659 (June 30) 1945.

that body proteins are depleted and protein metabolism is disturbed by disease processes. The frequency with which hypoproteinemia occurs in patients with malignant tumors of the gastrointestinal tract has been mentioned previously. Attention has been called to the important role that hypoproteinemia plays in wound healing, predisposition to shock, postoperative edema in wounds and surrounding suture lines, increased susceptibility to infection, anesthesia and hepatic dysfunction. Casual mention is made of these points with the sole idea of stressing the importance of correcting protein depletion and establishing large reserves of protein preoperatively as well as the maintenance of a positive nitrogen balance postoperatively.

PREPARATION OF THE BOWEL

Careful preparation of the bowel prior to surgical intervention has undoubtedly served as a tremendous factor in lowering the mortality rate following resection of the colon and rectum. Phthalylsulfathiazole (sulfathalidine®) has been our preference, being used routinely in doses of 0.1 Gm. per kilogram of body weight, as recommended by Poth.

In some instances, when a moderate degree of obstruction is present, the substitution of succinylsulfathiazole (sulfsuxidine®) is advisable because of its laxative effect. In regard to the use of agents for lowering the bacterial flora of the colon, it might be interesting to relate that our department, in conjunction with Professor Earl Spaulding, head of the department of bacteriology, has been investigating the efficacy of streptomycin administered orally. Zintel and others [8] have recently reported good results with this same method in reducing the coliform organisms, Streptococcus faecalis and the clostridial group. Our results have been somewhat at variance with those reported by this group and are given elsewhere in detail.[9] However, it should be stated that streptomycin holds promise as an adjunct in the preparation of the bowel for operation. Comparative results of the use of phthalylsulfathiazole, streptomycin and a combination of the two are shown in the accompanying charts. It should be stated that reversion was observed, for which reason administration of streptomycin for only two days prior to operation is recommended. Large doses of cathartics are contraindicated since dehydration, with more than probable loss of proteins and

8. Zintel, H. A.; Wyle, M.; Nichols, A., and Rhoads, C. P.: The Use of Streptomycin in Surgical Patients, Surgery **21**:178, 1947.

9. Rowe, R. J.; Spaulding, E., and Bacon, H. E.: Evaluation of Oral Streptomycin as an Adjunct in Preparing the Bowel for Surgery, read before the American College of Surgeons, New York city, September 1947. Bacon, H. E., and Rowe, R. J.: Preparation and After-Care of the Patient Undergoing Surgery of the Lower Bowel, read before the Gastroenterologic section, A. M. A., Atlantic City, New Jersey, June, 1947.

valuable water-soluble vitamins, occurs. Rectal irrigation with sodium bicarbonate and phthalylsulfathiazole is carried out, with aspiration from six to eight hours prior to operation. Thereafter, the rectal tube is left in situ and is taped to the buttocks. A Foley catheter is routinely employed. Additionally, a Levin tube is passed into the stomach and continuous suction applied during the operation to prevent vomiting and aspiration of vomitus. It is our opinion that this procedure has

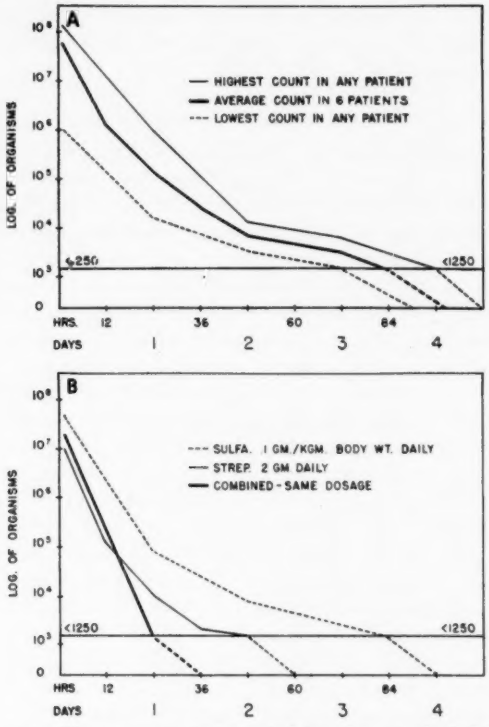

Fig. 1.—*A*, coliform counts during administration of phythalylsulfathiazole (sulfathalidine,® 0.1 Gm. per kilogram of body weight daily). *B*, average coliform counts.

definitely decreased the incidence of atelectasis. In impending obstruction, or as an adjunct to primary restriction, the mercury-weighted Miller-Abbott tube has proved useful. However, should definite evidence of obstruction be present, proximal enterostomy is preferable. In this group of patients, it is imperative to establish fluid and electrolyte balance prior to operative procedures.

CHOICE OF OPERATIVE PROCEDURES

Operative procedures for the removal of cancerous growths must, of necessity, conform to several qualifications. As nearly as possible, the growth and its extension to adjacent organs and to blood and lymphatic vessels, must be completely extirpated by a procedure com-

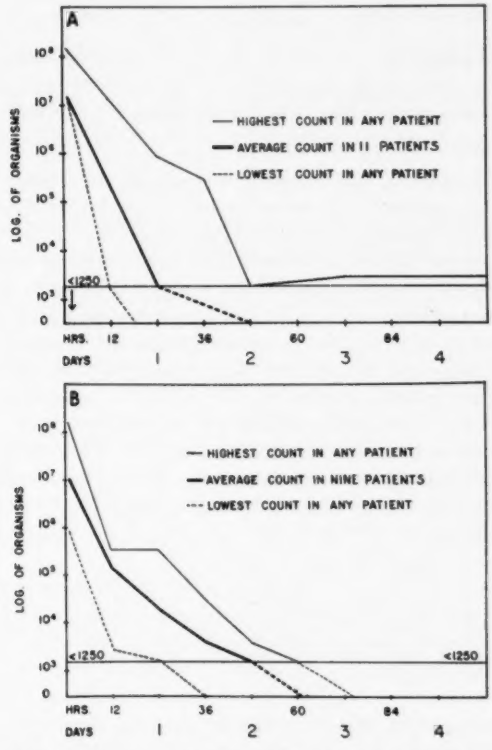

Fig. 2.—*A*, coliform counts with streptomycin (2 Gm. daily) and sulfathalidine® (0.1 Gm. per kilogram of body weight daily) combined. *B*, coliform counts with streptomycin (2 Gm. daily).

patible with life and the probability of longevity. Concomitantly, it should restore function that approaches the normal. It is our opinion that abdominoperineal proctosigmoidectomy is a procedure adequately meeting these qualifications in a large majority of cases in which there are cancerous lesions of the lower part of the bowel. Yet we do not believe that the procedure is applicable to every case. Prior to the

enumeration of the indications for proctosigmoidectomy or the delineation of the areas to which it must be restricted, it might be in order to discuss the incidence of cancer in the lower part of the bowel, lymphatic spread and the blood supply to that area. In an effort to determine the precise location of the lesion in the bowel, records of 180 consecutive patients were studied, and the following data were obtained:

Location of Lesion	Patients	
Sigmoid	23	
Rectosigmoid	53—33.8%	80.3%
Rectum (excluding lower 3 cm.)	73—46.5%	
Anal canal (including lower 3 cm. of rectum)	31—19.7%	
Total	180	

On the assumption that lesions in the sigmoid are resected solely by an abdominal approach and those located in the lowest 3 cm. of the rectum and anal canal by a method necessitating removal of the sphincters, there remain 80.3 per cent in which the sphincters may be preserved, if the findings in recent histopathologic investigations merit acceptance.

All recent studies relevant to the lymphatic spread of carcinoma of the lower part of the bowel, including those of Westhues, Collier, Gilchrist, Dukes and Bussey and Waugh and Grover, tend to show that malignant growths located in this region do not spread distally. In our group of 146 cases in which the removed specimens of bowel were sectioned serially at 2, 4 and 6 cm. caudad to the growth, invasion was observed in but 1 instance at the 6 cm. level. As a result of these findings, we have been led to conclude that the sphincter musculature may be preserved, providing the lower margin of the malignant growth is at least 6 cm. from the anal margin.

It is evident from the questions received concerning proctosigmoidectomy that relatively few understand the technic of the procedure. This has led to the assumption that unfamiliarity with it is mainly due to the fact that a misconception exists of the blood supply to the distal part of the colon, the mobility of the bowel and the amount of bowel that may be extirpated by this method.[10] Briefly, the blood supply to this area of bowel is derived from the inferior mesenteric vessel, through the left colic, the sigmoidal and the superior hemorrhoidal vessels. The sigmoidal vessels vary in number from one to seven and, contrary to some reports, form a well developed arcade with the left colic vessel. After interruption of the inferior mesenteric vessel just below the left colic, there still remains adequate blood flow to nourish the sigmoid colon.

10. Bacon, H. E., and Smith, C. H.: Blood Supply of the Colon and Rectum, Ann. Surg. **127**:1 (Jan.) 1948.

From results attained by us in terms of five year survival, proctosigmoidectomy does not at all comprise radicability. Based on the method suggested by Newman, of the British Ministry of Health, the following fraction is employed:

$$\frac{\text{Alive at 5 years} \times 100}{\text{Resection deaths, less the number of those who are untraced or who died of other causes}}$$

Thus, our incidence of five year cures based on 76 patients on whom abdominoperineal proctosigmoidectomy was performed five or more years ago is 52.6 per cent. In this group of 76 patients, there were 20 cases conforming to grade "A" classification, as shown in table 2.

POSTOPERATIVE MANAGEMENT

With proper preoperative care and attention to replacement of blood lost during the operative procedure, shock is seldom encountered. It

TABLE 2.—*Percentage of Five-Year Survivals Conforming to Grade "A"*

	Died Within 5 Years					
No. of Cases	Died from Operation	From Other Causes	of Cancer	Untraced	Alive at 5 Years	Percentage of 5 Year Cures
20	1	2	1	2	14	93.3%

has been our experience that whole blood is much more efficient in the prophylaxis and treatment of shock than plasma. In recent years, nutrition of the surgical patient from a postoperative standpoint has assumed a position of paramount importance. Intensive research has resulted in the discovery of protein hydrolysates which can be administered parenterally.[11] Similar advances have been attained in the field of parenteral administration of vitamins, and our knowledge of water and electrolyte balance has been materially extended.[12] Attention

11. Elman, R.: Amino Acid Content of the Blood Following Intravenous Injection of Hydrolyzed Casein, Proc. Soc. Exper. Biol. & Med. **37**:437 (Dec.) 1947.

12. Limbert, E. M.; Power, M. H.; Pemberton, J. D., and Wakefield, E. G.: Effects of the Parenteral Administration of Fluids on the Metabolism of Electrolytes During Postoperative Convalescence, Surg., Gynec. & Obst. **80**:609, 1945. Moyer, C. A.: Fluids and Electrolyte Balance, Surg., Gynec. & Obst. **84**:586, 1947. Yeomans, J. B.: Nutritional Deficiencies, Philadelphia, J. B. Lippincott Company, 1941, p. 233. Jones, C. M., and Eaton, F. B.: Postoperative Nutritional Edema, Arch. Surg. **27**:159 (April) 1933. Hartzell, J.; Winfield, J. S., and Irvin, J. L.: Plasma, Vitamin C, and Serum Proteins in Wound Disruption, J. A. M. A. **116**:669 (Feb. 22) 1941.

has been called to the important part that protein metabolism, particularly in regard to hypoproteinemia, plays in the preparation and aftercare of patients undergoing operation for a malignant tumor of the lower part of the bowel.[13] It is essential that an attempt be made postoperatively to maintain a positive nitrogen balance. In our patients, this is accomplished by the use of plasma, whole blood and from 60 to 120 Gm. of protein hydrolysate daily. In the estimation of fluid requirements, it is necessary to consider the average daily intake (2,500 to 3,500 cc.) and the loss of fluids from the body, i. e., the estimated loss from both the kidneys and the gastrointestinal tract and in addition that from Wangensteen suction, as well as the insensible loss from the skin and the lungs. In our experience, the urinary output has proved to be the most valuable index of the status of body water balance. In conjunction with this, the erythrocyte count, hemoglobin content, hematocrit value, serum protein, carbon dioxide content, serum chloride and urinary chloride and the specific gravity, together with the urinary p_H, are necessary determinants of rational fluid replacement. All fluid losses from suction, ileostomy or the presence of a fistula must be computed and replacement of similar electrolytic substances instituted. Attention should be invited to the danger of intoxication with salt, since it has been demonstrated that patients tolerate poorly any large amount of salt during the early postoperative periods.[14]

Postoperative Ileus.—After abdominal operations, a varying degree of temporary paralysis of the bowel is present. The condition is usually referred to as "physiologic ileus," and its severity is in direct proportion to the degree of injury sustained by the viscera and peritoneum. When infection or further peritoneal irritation, such as leakage from the bowel anastomosis, is superimposed on this condition, the result is adynamic ileus. In either condition, intestinal stasis occurs, with the resultant accumulation of gas and fluid in the intestinal tract. Fully 60 per cent of intestinal gas is swallowed, and large amounts of fluid are secreted into the stomach and the small intestine. It is obvious, then, that gastroduodenal suction should be instituted immediately after abdominal operations to prevent intestinal distention until motility of the bowel returns. Its advantage in instances of postoperative adynamic or dynamic ileus is also well recognized. In cases of the adynamic type as well as the dynamic type occurring postoperatively with no evidence of circulatory disturbance, the Miller-Abbott tube or one of its variations has proved beneficial. Experience in the use of the tube is necessary to achieve

13. Lund, C. C., and Levenson, S. M.: Protein in Surgery, J. A. M. A. **128**:95 (May 12) 1945.

14. Maddock, W. G., and Coller, F. A.: Water Balance in Surgery, J. A. M. A. **108**:1 (Jan. 2) 1937. Coller, F. A.; Campbell, K. M.; Vaughan, H. H.; Job, V., and Moyer, C. A.: Postoperative Salt Intolerance, Ann. Surg. **119**:533, 1944.

the best results, and there should be constant observation to see that it is functioning properly. Prophylaxis is the best treatment for ileus, including routine postoperative gastric or intestinal suction and the use of high concentrations of oxygen.

Thromboembolism.—Since the introduction of the newer antibiotics and sulfonamide compounds, death from infection is the exception rather than the rule. Because of this fact, the attention of surgeons has been drawn to other less frequent causes of death. Thus, an unprecedented interest has arisen in the thromboembolic diseases.[15] Although not at first apparent, justification for this is demonstrated in our series of 439 operative procedures on the bowel, in which 5 deaths occurred from pulmonary embolism. For a period of over two years a rigid prophy-

TABLE 3.—*Data on Thromboembolism*

Operations on the Bowel (Largely Abdominoperineal Proctosigmoidectomies)	Fatal Pulmonary Emboli	Mortality, Percentage
Prior to August 1945—439	5	1.1
Subsequent to August 1945—390	1	0.2

Prophylactic Measures	Indications for Anticoagulant Therapy
1. Early exercises of legs hourly when awake	1. Tenderness over deep calf veins: (*a*) Homan's sign. (*b*) Moses' sign (New England J. Med. **234**:288, 1946)
2. Early unassisted movement in bed	2. Unexplained concomitant rise in temperature and pulse (*a*) Allen's sign
3. No pillows under knees	3. Previous embolic phenomena
4. Vigilant daily examinations for early signs of deep venous thrombi of lower extremities	4. Evidence of superficial or deep thrombophlebitis
5. Early ambulation, 2 to 5 days, depending on operation	5. Circulatory disturbance of lower extremities
6. Elastic bandages for selected patients	6. Cardiac disease

Therapy: Combination of heparin and "dicumarol."

lactic regimen has been instituted, the results from which are given in table 3.

Atelectasis.—This condition is one of the most common of postoperative complications in our experience and becomes manifest early by a sharp rise in temperature. The diagnosis is usually not too difficult clinically if attention is paid to the increased respirations, chest lag on the affected side, decreased breath sounds and shifts of the heart and trachea. Adequate roentgenograms, and not bedside films, are diagnostic. Treatment should be immediate removal of the bronchial

15. Homans, J.: Venous Thrombosis in the Lower Limbs; Its Relation to Pulmonary Embolism, Am. J. Surg. **38**:313, 1937. Allen, A. W.; Linton, R. R., and Donaldson, G. A.: Venous Thrombosis and Pulmonary Embolism: Further Experience with Thrombectomy and Femoral Vein Interruption, J. A. M. A., **128**:397 (June 9) 1945. Detakats, G., and Fowler, F. F.: The Problem of Thrombo-Embolism, Surgery **17**:156, 1945.

obstruction by either suction with an intratracheal catheter or bronchoscopy.

Genitourinary Complications.—Postoperatively, continuous drainage of the bladder and frequent irrigations are used until vesical function has returned to normal as evidenced by cystometric studies and the amount of residual urine present. Transurethral resection has been unnecessary.[16]

Wound Complications.—Concerning the care of wounds and wound complications, it may be stated that with the use of stainless alloy steel wire for closure and the concomitant use of sulfonamide drugs and antibiotics the incidence of complications has been reduced to a minimum.

In general, the morbidity compares favorably with that for one or the other type of resection. Customarily the patient is permitted out of bed on the fifth postoperative day and discharged on the eleventh day. Ordinarily, he returns to his active pursuits between six and ten weeks after operation.

225 South Seventeenth Street.

16. Bacon, H. E., and McCrae, L. E.: Abdominoperineal Proctosigmoidectomy for Rectal Cancer: Management of Associated Vesical Dysfunction, J. A. M. A. **134**:523 (June 7) 1947.

CARCINOMA OF THE COLON AND RECTUM

A Ten Year Study

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IN JANUARY 1943 [1] there was published from this service a paper discussing the complications and mortality following radical operations for cancer of the colon and rectum. The present communication represents in part a continuation of that study and includes an appraisal of the surgical therapy of this disease in a modern urban medical center, with the greater importance being paid to the operative mortality and to long term follow-up studies.

It was originally intended to report on the patients treated on the ward service only. However, as time went on during this study, it became clear that it would be of considerable interest if we included a comparable series of cases from the private practice of one of us (J. H. G.), in order to emphasize certain features which became evident as the analysis of the two series progressed. The combined series comprises a total of 910 cases, 549 from the ward service and 361 among the private group.

In the paper alluded to a statement was made, which, in the light of added experience, seems important enough to repeat at this time.

> It is important to stress that many of the patients admitted to the wards of the Mt. Sinai Hospital do not represent the best physical material for major surgical procedures. Serious cardiovascular disease is common, as are diabetes and kidney disease. Many of the patients have led sedentary lives with little physical exercise, with the result that muscle tone is poor and the speed of recuperation is greatly reduced. Nutritional disturbances are common and there is great susceptibility to pulmonary infections. We are convinced that these factors are of considerable importance in influencing the mortality of major abdominal surgery in a large group of cases. There is a great difference in the physical status of ward patients living in large urban centers and those coming from rural communities. We do not believe that this has been stressed sufficiently in the past and that it may be an important reason for the disparity in the operative mortality statistics reported from various sections of the country.

From the Surgical Service of the Mount Sinai Hospital.
Presented at the New York Surgical Society, Jan. 14, 1948.

1. Garlock, J. H.; Ginzburg, L., and Glass, A.: Complications and Causes of Mortality of the Surgical Treatment of Carcinoma of the Colon and Rectum, Surg., Gynec. & Obst. **76**:51-59 (Jan.) 1943.

In spite of the most modern methods of preoperative preparation, with great care paid to the patient's protein, electrolyte, mineral and vitamin needs, and in spite of the great advance in recent years along the lines of antibiotic therapy, we believe that this statement still holds true. There is no doubt that there has been an appreciable reduction of operative mortality all over the country since the need for careful preoperative preparation was generally appreciated. The advent of the antibiotics has played a great part in the progress of gastrointestinal surgery in the past decade, but in spite of this, there are many intangible factors which influence to a great extent the morbidity and mortality in the group of patients under consideration in this article. A careful study of the two comparative series emphasizes this fact most clearly.

In order to minimize and in part overcome the complicating medical disabilities enumerated, we formulated ten years ago a plan of preoperative rehabilitation, surgical procedure and postoperative care which we have continued during the years with certain modifications as experience increased. The preoperative period of preparation was frequently prolonged for two to three weeks to overcome anemia and nutritional disturbances and to treat cardiovascular disabilities and renal complications. In the majority of instances it was necessary to employ staged operative procedures. Finally, great attention was paid to the details of the postoperative care, which was found to equal in importance the preoperative period of rehabilitation.

With this plan it soon became evident that our incidence of operability increased. Operability and mortality are closely related. Factors which influence operability have a direct bearing on mortality. It has been amply demonstrated in many clinics that by extending the scope of operability the mortality rate increased, but with a proportionate increase in the number of patients surviving the five and ten year periods. These facts have influenced us in accepting for radical procedures patients who might otherwise have been rejected for fear of an increase in the operative mortality. Except in rare instances and in unusual circumstances, our index of operability has not been influenced by such considerations as age of the patient, obesity, loss of weight, anemia or associated chronic diseases. However, we are particularly wary of the patient who has had recent coronary thrombosis. It has been our experience that such patients withstand radical operations poorly. In general, it may be said that our index of operability has been influenced much more by conditions associated with the growth per se, such as fixation to neighboring vital structures and extensive hepatic metastasis. In many instances, operability was extended by the radical removal of involved contiguous organs such as a loop of small bowel, posterior wall of the bladder, uterus, vagina or adnexae or a portion of the abdominal wall.

The extent of lymph node involvement influences operability to a great degree, and the decision to perform a radical operation will rest, first, on the resectability of the involved nodes, second, on the accuracy with which the cause of the enlargement of nodes (neoplastic or inflammatory) is interpreted and, third, on the experience and boldness of the surgeon. The finding of metastasis to the liver at the time of exploration renders the situation hopeless, of course, from the standpoint of cure. However, with the knowledge that the patients with hepatic involvement not infrequently survive for as long as three years, it is justifiable to perform a resection of the colon for an operable local tumor, especially if it is producing obstructive symptoms or if the tumor is a large infected one, as is frequently found in the right colon.

It is not our purpose in this communication to describe in detail the methods utilized to rehabilitate many of the patients before operation. The majority of the patients in this series have been prepared for a period of five to seven days. The routine preparation consists of the use of a low residue intake, initial cleansing of the bowel with mild purgation, colonic irrigations, the administration of succinylsulfathiazole or phthalylsulfathiazole and the liberal use of blood transfusions preoperatively when indicated. Complicating medical disabilities are treated accordingly. Frequent use has been made of the Miller-Abbott tube when contemplating intestinal anastomosis.

In cases of acute intestinal obstruction due to carcinomas of the colon, recourse has been made to the operation of an exteriorized cecostomy. It is well known that colonic distention cannot be adequately relieved by the use of the Miller-Abbott tube alone. The Miller-Abbott tube will decompress the small bowel only, and there will remain a distention of the colon between the ileocecal valve and the obstructing tumor. Ill advised prolonged use of the Miller-Abbott tube in the hope that decompression of the large bowel will take place may lead to perforation of a markedly distended cecum. We should also like to stress the fact that no operative maneuvers should be carried out on the tumor-bearing portion of the bowel in the presence of an acute or subacute intestinal obstruction. If the surgeon at the time of exploration is confronted by a markedly distended large bowel proximal to the tumor, he should be content to limit the operative maneuver at this stage to a decompressing procedure and to defer his resection for a later date.

There has been no routine anesthesia in this group of patients. In the majority of instances, general anesthesia has been administered in the form of carbon dioxide, oxygen and ether or cyclopropane or ethylene and ether. Some of the members of the service have used spinal anesthesia, frequently of the continuous type. The choice of the anes-

thetic agent has, in the majority of cases, been delegated to the anesthetist. An effort has been made to individualize the patients and to pick the anesthetic agent for the particular problem at hand. In the same way, we have chosen a particular operative procedure to take care of the individual problem presented by each patient. Individualization of the patient has been the prime consideration at all times.

ANALYSIS OF CASES

We have arbitrarily divided the patients in this series according to anatomic sections of the colon and rectum. In each group we present comparative figures from the ward service and from the private group (table 1).

Carcinoma of the Right Side of the Colon.—Among the ward group there were 93 patients in this category, as opposed to 54 patients in

TABLE 1.—*Carcinoma of the Colon and Rectum*

Ward Series	
Right side of colon (cecum, ascending colon and hepatic flexure)	93 (16.9%)
Transverse colon	27 (4.9%)
Splenic flexure	19 (3.5%)
Descending colon and sigmoid colon	145 (26.4%)
Rectosigmoid colon and rectum	265 (48.3%)
Total	549*
Private Series	
Right side of the colon	54 (14.9%)
Transverse colon	27 (7.5%)
Splenic flexure	9 (2.5%)
Descending colon and sigmoid colon	109 (30.2%)
Rectosigmoid and rectum	162 (44.9%)
Total	361†

* The number of patients was 544. The lesions include six "double" lesions, necessitating multiple resection operations (table 2).

† The number of patients was 361. There was 1 "double" carcinoma, requiring multiple resection operations—one stage ileocolic resection for carcinoma of the right colon and obstructive resection for carcinoma of the transverse colon.

the private series (tables 2 and 3). In the ward group there were 62 operable cases, an operability rate of 66.7 per cent. This is to be compared with a rate of 81.5 per cent in the private series (table 2). In the first group the operative mortality in the cases of resectable tumors was 8.1 per cent, and in the second group it was 6.8 per cent. The accompanying tables indicate the subdivision for the one and two stage operations. It has been our experience that many patients with tumors on the right side are in a markedly depleted condition when admitted to the hospital, usually with a severe secondary anemia simulating, sometimes, pernicious anemia and associated with considerable disturbances in the protein metabolism. In spite of adequate and thorough preoperative rehabilitation, our experience has indicated that it is wiser in the majority of instances to stage the resection, the first operation consisting of an ileotransverse colostomy with exclusion of the ileum, and the second stage, performed approximately three weeks

TABLE 2.—*Carcinoma of the Right Side of the Colon*

Ward Series

Total number of cases—93

A. Operable.....62 (66.7%); (5 deaths—8.1% mortality)
   Procedures performed:
   (*a*) One stage ileocolectomy.....12 (2 deaths—16.7%)
   (*b*) Staged procedures
      1. Ileocolostomy with exclusion; ileocolic resection.....47 (1 death—2.1%)
      2. Ileocolostomy with exclusion (first stage of proposed two stage resection).....1 (1 death)
      3. Ileocolic obstructive resection.....2 (1 death)
      Total.....50 staged procedures (3 deaths—6.0% mortality)
   Causes of Death
      1. Multiple abscesses of the liver (autopsy)
      2. Intestinal obstruction (autopsy)
      3. Pneumonia (no autopsy)
      4. Sulfanilamide hepatitis (no autopsy)
      5. Cause not clear (no autopsy)

B. Inoperable 31 (33.3%)
   Procedures performed
   (*a*) Exploratory laparotomy 3
   (*b*) Palliative operations.....28 (7 deaths—25.0% mortality)

Private Series

Total number of cases—54

A. Inoperable group.....10 (18.5%)—palliative ileocolostomy with exclusion performed. No postoperative deaths

B. Operable group.....44 (81.5%)
   (*a*) One stage ileocolic resection.....22; postoperative deaths, 2 (9.1%)
   (*b*) Two stage ileocolic resection.....22; postoperative deaths, 1 (4.5%)
   Combined mortality of groups *a* and *b*.....6.8%
   Causes of Death
      1. Coronary artery occlusion
      2. Local peritonitis due to slough of inverted end of colon
      3. Cause undetermined

TABLE 3.—*Carcinoma of the Transverse Colon*

Ward Series

Total number of cases—27

Operable group.....16 cases (59.3%); 2 deaths (12.5% mortality)
   Procedures performed
      Resection and primary anastomosis; complementary cecostomy..... 1
      Primary ileosigmoidostomy with exclusion; secondary right hemicolectomy... 2
      Primary obstructive resection; secondary spur crushing and colostomy closure..11
      Obstructive resection 1
         (died; clinical picture of cerebrovascular accident and terminal pneumonia; no autopsy)
      Ileotransverse colostomy with exclusion..... 1
         (died; clinical picture of uncontrollable gastric hemorrhage; autopsy: peptic ulcer and pulmonary embolism)

Inoperable group.....11 cases (40.7%)
   Exploratory laparotomy 3
   Palliative procedures 8
      Cecostomy 2
      Ileosigmoidostomy.....4 (1 death; autopsy: bronchopneumonia)
      Primary cecostomy, for obstruction; secondary ileosigmoidostomy..... 1
      Primary cecostomy, for obstruction; secondary exploratory laparotomy (inoperable) 1

Private Series

Total number of cases—27

Inoperable group 5 (18.5%)
   Procedures performed
   (*a*) Exploratory laparotomy 2
   (*b*) Palliative procedures 3
      (obstructive resection, 1; ileosigmoidostomy with exclusion, 2)
      (no postoperative deaths)

Operable group 22 (81.5%)
   Procedures performed
   (*a*) Obstructive resection 21
   (*b*) Resection with end to end anastomosis..... 1
      (no postoperative deaths)

later, consisting of an ileocolic resection. Study of the accompanying charts will indicate the marked difference in operative mortality, with the single and two stage operations, in the ward group 16.7 per cent for the one stage ileocolectomy and 6 per cent for the staged operation. In the private series, the comparative figures are 9.1 and 4.5 per cent. The argument has been frequently advanced that the two stage operation offers the patient two chances to die and therefore the one stage operation should be done in the majority of instances. Our experience has been in direct contradistinction to this thought. In the combined group of 72 patients subjected to the two stage operation only 1 patient died after the first procedure. A study of table 2 will indicate the causes of death in the operable group of the two series and the findings when permission for postmortem examination was obtained.

Carcinoma of the Transverse Colon.—In this group there were 27 patients in the ward group and 27 in the private group. The operability in the first was 59.3 per cent and in the second 81.5 per cent. Table 3 will indicate the procedures carried out in both the operable and the inoperable groups of both series. It will be noted that the vast majority of radical procedures consisted of obstructive resections, with the formation of a double-barreled colostomy opening which was closed at a later date. This brings up the general problem of obstructive resection as opposed to resection with primary anastomosis, which is now being carried out with increasing frequency throughout the country. To go into this problem extensively would carry us far afield and beyond the original intent of this paper. Suffice it to say that when the study of the problem of carcinoma of the colon was begun on this service, the necessity for staged procedures soon became evident. After the general adoption of the staged operation program, there was noted a pronounced reduction in the operative mortality. Since the advent of the sulfonamide compounds for intestinal antisepsis and the more general appreciation of the great need for careful preoperative rehabilitation, there has been an increased tendency throughout the country to return to the operation of resection and anastomosis which was practiced by many of the surgeons more than a quarter of a century ago. We all find that we are increasing our number of cases of primary anastomosis as time goes on, but we should like to emphasize that the operation of obstructive resection is still an excellent one, is a good operation for cancer and carries with it a commendably low mortality rate. In addition, our experience indicates that there is a vast difference in the smoothness of the postoperative course of the two types of operation. Our morbidity following obstructive resection has been much less than with the operation of primary anastomosis. We have set down definite criteria for the use of this operation. We

believe that it should not be carried out in the following circumstances: (1) when there is any evidence of obstruction proximal to the tumor; (2) when there is marked obesity of the patient, with infiltration of fat in the mesentery of the bowel; (3) when patients in the older age groups are being dealt with, on whom it is important to carry out a rapidly executed procedure so that they can be taken off the operating table as soon as possible, and (4) in the presence of pericolonic infection.

If none of these complicating factors is present, we believe that it is safe to carry out the operation of resection and primary anastomosis supplemented by a proximal decompressing tube cecostomy. The purpose of the cecostomy is to prevent gaseous distention of the colon in

TABLE 4.—*Carcinoma of the Splenic Flexure*

Ward Series	
Total number of cases—19	
Inoperable group	5 (26.3%)
Procedures performed	
(a) Exploratory laparotomy	1
(b) Palliative operations	3 (2 deaths)
(Cecostomy for obstruction; patient died; autopsy showed peritonitis secondary to perforation of the obstructed colon.	
Ileosigmoidostomy with exclusion; patient died: autopsy showed peritonitis secondary to perforation of the tumor	
Obstructive resection)	
Operable group	14 (73.7%); 2 deaths (14.3%)
Procedures performed	
(a) Obstructive resection	10
(2 deaths. One patient died suddenly on the 11th postoperative day with pulmonary embolism (?), pulmonary thrombosis (?); no autopsy. The other had profuse bleeding from the proximal colostomy limb; no autospy)	
(b) Primary cecostomy for obstruction, secondary to obstructive resection	4
Private Series	
Total number of cases—9	
Inoperable group	2 (22.2%)
Procedures performed: obstructive resection (no deaths)	
Operable group	7 (77.8%)
Procedures performed: obstructive resection (no deaths)	

the region of the anastomosis. It can be done quickly at the same sitting or, if necessary, as a preliminary procedure. The mortality for the operable cases was 12.5 per cent in the ward series; there were no deaths in the private group (table 3).

Carcinoma of the Splenic Flexure.—We believe that cases of carcinoma of the splenic flexure should be specially considered because of the inherent technical difficulties associated with operative resections in this region. The old writers emphasized the high mortality associated with resection for this condition. There were 19 cases in the ward group and 9 in the private group. The operability rate was 73.7 per cent in the first as opposed to 77.8 per cent in the second. In the operable group the mortality figures were 14.3 per cent and zero respectively. Table 4 indicates the essential features of the two groups.

Carcinoma of the Descending Colon and the Sigmoid Colon.—In the ward series there were 145 patients as compared with 109 in the private series. There were 4 patients in the ward group who under-

TABLE 5.—*Carcinoma of the Descending and Sigmoid Portions of the Colon: Postoperative Mortality in the Ward Series*

(Total number of cases: 145)	Number of Cases	Deaths	Mortality, %
A. Inoperable group	49 (33.8%)	10	20.4
B. Questionably operable group	4 (2.8%)	4	100.0
C. Operable group	92 (63.4%)	6	6.5
Group B plus group C	96 (66.2%)	10	10.4

TABLE 6.—*Carcinoma of the Descending and Sigmoid Portions of the Colon: Operable Group in the Ward Series.*

A. Obstructive resection.....88 cases (7 deaths—7.95% mortality)
B. Resection and end to end anastomosis.....3 cases
  1 case: (*a*) Preliminary decompressive colostomy; (*b*) Resection of neoplasm and involved adherent small bowel and anastomosis; (*c*) Closure of primary colostomy
  2 cases: (*a*) Preliminary decompressive colostomy; (*b*) Resection of neoplasm and anastomosis; (*c*) Closure of primary colostomy
C. Sigmoidotomy and excision of adenomatous polyp showing carcinomatous degeneration.....1 case

TABLE 7.—*Carcinoma of the Descending and Sigmoid Portions of the Colon: Mortality in Obstructive Resection Group*

(*a*) Decompressive cecostomy; (*b*) Obstructive resection; (*c*) Closure of colostomy; (*d*) Closure of cecostomy	Died 4th postoperative day; no autopsy	High intestinal obstruction developed after last operation; jejunostomy performed
Obstructive resection	Died suddenly 5th postoperative day; no autopsy	Clinical picture of acute coronary occlusion; patient known preoperatively to have severe myocardial damage
Obstructive resection and drainage of pelvic abscess	Died on 43rd postoperative day; autopsy: pituitary tumor, bronchiectasis and bronchopneumonia, emphysema, atelectasis and purulent bronchitis; cardiac hypertrophy	First week pneumonia and cardiac failure; fifth week convulsions and coma
Obstructive resection	Died on 12th postoperative day; autopsy: pulmonary embolism	
Obstructive resection	Died on 29th postoperative day; autopsy: acute right pyelonephritis, acute suppurative bronchopneumonia of lower lobe of left lung	Auricular fibrillation, pneumonia, bacteremia and ascending urinary infection clinically
(*a*) Decompressive cecostomy; (*b*) Obstructive resection	Died on 3rd postoperative day	Autopsy: pulmonary embolism, peritonitis localized around colostomy; hypernephroma on left side
Obstructive resection and resection of loop of involved ileum	Died on 8th postoperative day	Autopsy: intestinal occlusion; bronchopneumonia

went primary decompressing cecostomy for acute intestinal obstruction but who died before coming to the second procedure. We are therefore unable to determine whether theirs were operable tumors. If these

are excluded then the operability rate in this group was 63.7 per cent. If they are to be included, the rate becomes 66.2 per cent. In the group of 109 private patients the operability rate was 77.1 per cent. Tables 5 to 8 bring out clearly the details of the operations performed in both series. The operative mortality in the ward series for the operable group was 6.5 per cent. If the 4 patients described previously are included in the calculation, then the gross mortality for this group

TABLE 8.—*Carcinoma of the Descending and Sigmoid Portions of the Colon in the Private Series*

Total number of cases—109	
A. Inoperable group	25 (22.9%)
Procedures performed	
(a) Exploratory laparotomy	3
(b) Palliative operations	
1. Colostomy	3
2. Obstructive resection	18
(1 postoperative death due to peritonitis)	
B. Operable group	84 (77.1%; postoperative mortality, 1.2%)
Procedures performed	
(a) Obstructive resections	80
(including 1 case with partial resection of bladder; no deaths)	
(b) Resection with end to end anastomosis	3 (no deaths)
(c) Cecostomy for acute descending colon obstruction	1
(this patient died postoperatively; autopsy: chronic ulcerative colitis, perforation of the carcinoma with abscess formation and peritonitis)	

TABLE 9.—*Ward Series: Carcinoma of the Rectosigmoid Colon and the Rectum (265 Cases)*

Inoperable group	76 (28.7%)
Postoperative deaths	19 (25%)
Procedures performed	
A. Exploratory laparotomy..9 (1 death [11.1%]; autopsy: pulmonary embolism)	
B. Palliative procedures	67 (18 deaths, 28.9%—table 16)
Colostomy	58
Resection of gangrenous sigmoid volvulus about rectosigmoid carcinoma	1
Obstructive resection	2
Anterior resection	2
Primary colostomy; secondary enterostomy for peritonitic ileus	1
Two stage abdominoperineal resection	1
Colostomy and resection (and anastomosis) of small bowel loop	1
Drainage of pelvic abscess and peritonitis	1

becomes 10.4 per cent. In the private series the postoperative mortality was 1.2 per cent.

Carcinoma of the Rectosigmoid and the Rectum.—Cases of this constitute the largest group in the entire series. Among the ward cases there were 265, and the private cases totaled 162. The operability rate in the ward group was 71.3 per cent as compared with 91.3 per cent in the private series. Tables 9 to 13 indicate the various procedures that were utilized in the operative therapy of this disease. The comparable general operative mortality was 21.2 and 8.8 per cent. The accompanying tables also indicate the comparable mortality in the two

groups following each type of operation. It is interesting to note that the mortality following abdominoperineal resections is noticeably higher than that following the operation of anterior resection with anastomosis.

TABLE 10.—*Surgical Procedures Performed for Carcinoma of the Rectosigmoid Colon and the Rectum in the Ward Series (189 Cases [71.3 %])*

Abdominoperineal resection	
A. One stage "combined" operation (including 1 case in which disconnection of the mechanism of a previous ileosigmoidostomy which had been done elsewhere and ileoileostomy were performed)	118
B. Staged procedures	
1. First stage: decompressive colostomy for obstruction Second stage: abdominoperineal resection	4
2. First stage: obstructive resection of carcinoma of rectosigmoid (colostomy not closed Second stage: abdominoperineal resection of carcinoma of rectum	1
3. Lahey type two stage abdominoperineal resection (including 3 cases in which total hysterectomy was performed because of neoplastic invasion)	17
4. Miscellaneous	
(*a*) Diffuse polyposis of the colon and carinoma of the rectum First stage: ileostomy Second stage: abdominoperineal resection Third stage: total colectomy	1
(*b*) Polyposis of left half of colon and carcinoma of the rectum Six years previously: First stage: ileostomy; Second stage: hemicolectomy to rectosigmoid; Third stage: hemicolectomy to rectosigmoid; Fourth stage: abdominoperineal resection First stage: abdominoperineal resection Second stage: left hemicolectomy	2
C. Hartmann procedure (in 1 case included partial cystectomy, suprapubic cystostomy and total resection of uterus and adnexa)	4
D. Obstructive resection (carcinoma of rectosigmoid colon) (in 1 case included partial cystectomy)	3
E. Colotomy and local excision of villous adenoma of rectosigmoid colon, showing carcinomatous transformation	1
F. Local excision of villous adenoma of rectum showing foci of carcinomatous transformation	1
G. Colostomy 3 cases, first stage of proposed Lahey operation 1 case, first stage of proposed Lockhart-Mummery operation	4
H. Anterior resection, with end to end anastomosis	19
First stage: decompressive colostomy for obstruction Second stage: anterior resection with end to end anastomosis Third stage: closure of colostomy	4 cases
First stage: elective preliminary diverting colostomy Second stage: anterior resection with end to end anastomosis Third stage: closure of colostomy	1 case
First stage: anterior resection with end to end anastomosis and complementary transverse colostomy Second stage: closure of colostomy	11 cases
(*a*) 1 case in which obstructive resection of a splenic flexure carcinoma had been done five weeks previously (*b*) 1 case in which two stage ileocolectomy for carcinoma of ascending colon had been done five weeks previously (*c*) 1 case in which two stage ileocolectomy had been done for carcinoma of ascending colon four years previously	
First stage: anterior resection with end to end anastomosis and complementary sigmoid colostomy Second operation: Perineal presacral incision and drainage for infection Second stage: closure of colostomy	3 cases
I. Lockhart-Mummery resection (*a*) Preliminary colostomy (*b*) Secondary perineal resection	14

It will be noted by a careful perusal of table 11 that we have been fortunate in obtaining permission for autopsy in a high percentage of cases in the ward series. In the total group of 40 deaths, there were

TABLE 11.—*Causes of Death in the Operable Group with Carcinoma of the Rectosigmoid Colon and the Rectum in the Ward Series*

Cause of Death	Autopsy	No Autopsy	Total
Shock	..	1	1
Coronary artery occlusion	1	..	1
Pneumonia	7	..	7
Pneumonia and peritonitis	1	..	1
Peritonitis	7	1	8
Myocardial failure	4	..	4
Cerebrovascular accident	2	1	3
Acute intestinal obstruction	1	2	3
Pulmonary embolism	3	1	4
Massive hemorrhage from duodenal ulcer	1	..	1
Pulmonary atelectasis	1	..	1
Hemoglobinuric renal degeneration (transfusion reaction)	1	..	1
Jaundice and paralytic ileus	1	..	1
Hepatic damage and coronary insufficiency	1	..	1
Peritonitis and pulmonary embolism	1	..	1
Miliary tuberculosis	1	..	1
Sepsis (Staphylococcus aureus)	1	..	1
Total	34	6	40

TABLE 12.—*Postoperative Mortality in the Operable Group with Carcinoma of the Rectosigmoid Colon and the Rectum in the Ward Series*

Procedures Performed	No. of Cases	Survived	Died	Mortality, %	
Abdominoperineal resection	126	97	29	23.0	} 143 (31 deaths)
Lahey two stage abdominoperineal resection	17	15	2	11.8	} mortality, 21.7%
Lockhart-Mummery resection	14	12	2	14.3	
Hartmann procedure	4	2	2	50.0	
Colotomy and local excision	1	1	0	0	
Local excision per rectum	1	1	0	0	
Obstructive resection	3	3	0	0	
Anterior resection	19	18	1	5.3	
Colostomy	4	0	4	100.0	
Total	189	149	40	21.2	

TABLE 13.—*Carcinoma of the Rectosigmoid and Rectum in the Private Series*

Total number of cases—162

A. Inoperable group 14 (8.65%)
Procedures performed
(*a*) Exploratory laparotomy 5
(1 postoperative death, due to intra-abdominal metastasis)
(*b*) Palliative operations.....9 (obstructive resection, 1; colostomy, 7; abdominoperineal resection, 1)

B. Operable group 148 (91.35%)
Procedures performed
(*a*) Abdominoperineal resection 99
in one stage, 96 (10 deaths—10.4%) in two stages, 3 (no mortality)
combined mortality, 10.1%
(*b*) Anterior resection and anastomosis, with complementary temporary proximal colostomy.....37 (2 deaths) mortality, 5.4%
(*c*) Hartmann resection 2
(*d*) Local excision per rectum of small adenomatous polyp showing early carcinomatous degeneration 1
(*e*) Lockhart-Mummery resection 2
(*f*) Obstructive resections .....7 (1 death—14.2%)

Total.....148; deaths, 13 (8.8%)

8 instances of peritonitis, and of these, 7 were proved by postmortem examination. We might emphasize that this complication has been most unusual during the past four or five years. The majority of the deaths have been due mainly to complications caused by associated medical disabilities.

FOLLOW-UP STUDIES

In an urban center like New York city, with its constantly shifting population, it is difficult to follow patients for as long a period as is required for a study such as this. This was especially difficult during the war years. We were, naturally, able to obtain a higher percentage of late follow-up examinations in the group of private patients. This analysis has emphasized two important facts:

1. In the group of patients with lymph node involvement at the time of operation the curve of long term survivors falls rapidly as the years go by. The greatest number of survivors are in the group in which spread to lymph nodes does not occur.

TABLE 14.—*Carcinoma of the Colon and Rectum in Combined Total of Ward and Private Series (910 Cases)*

Mortality in the Operable Cases	Ward Series		Private Series	
	Operable Cases	Deaths	Operable Cases	Deaths
Right colon	62 (66.7%)	5 (8.1%)	44 (81.5%)	3 (6.8%)
Transverse colon	16 (59.3%)	2 (12.5%)	22 (81.5%)	0
Splenic flexure	14 (73.7%)	2 (14.3%)	7 (77.8%)	0
Descending colon and sigmoid colon	96 (66.2%)	10 (10.4%)	84 (77.1%)	1 (1.2%)
(including 4 questionably operative cases—4 deaths)				
Rectosigmoid colon and rectum	189	40 (21.2%)	148 (91.35%)	13 (8.8%)
Total	377 (68.6%)	59 (15.6%)	305 (81.2%)	17 (5.6%)
Combined group, 682 (74.9%); 76 deaths (11.1%)				

2. As the experience of the individual surgeon increases, he will undertake more radical resections, with a resultant increase in his rate of operability and a consequent increase in the number of long term survivors.

A study of tables 15 and 16 will indicate that the greatest number of survivors proportionately are in the groups with carcinoma of the right side of the colon and the rectum, in that order. It is possible that the prognosis for neoplasms of the right side is better because of the greater ease of more radical resections by virtue of the anatomy of the mesentery and its contained lymph nodes. However, there are certain pathologic features based on clinical operative experience which indicate fundamental differences between cancer on the right side and cancer on the left side. From the large experience indicated by the report in this paper, it is apparent that the neoplasms on the right side grow in a centrifugal or centripetal direction, with the formation, in the main, of large ulcerating tumors, and that cancerous lymph node spread is not nearly as frequent as with tumors on the left side.

TABLE 15.—*Follow-Up of Operable Cases in Ward Series*

	Lymph Node or Pericolic Involvement	Total	Known to Be Alive and Well (Years)										Died or Had Recurrence
			0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	
Right side of colon														
1937-1942	—	15	1	..	..	..	1	3	2	..	2	1	..	2
	+	9	..	..	..	1	..	..	..	..	..	..	..	8**
1942-1947	—	24	2	6	1	2	1	..	..	..	..	..	..	10§§
	+	9	1	3	1	..	..	..	..	..	..	..	..	3
Transverse colon														
1937-1942	—	5	..	..	..	..	..	3	1	..	..	1	..	..
	+	3	..	..	..	..	..	..	..	..	..	..	..	3
1942-1947	—	6	1	2	..	..	1	..	..	..	..	..	..	1
	+	0	..	..	..	..	..	..	..	..	..	..	..	..
Splenic flexure														
1937-1942	—	5	..	..	..	..	..	..	..	2	..	..		3‡
	+	1	..	..	..	..	..	..	..	..	..	..		1
1942-1947	—	4	1	3	..	..	..	..	..	..	..	..		..
	+	2	..	..	..	..	1	..	..	..	..	..		1
Descending and sigmoid portions of colon														
1937-1942	—	14	1	1	..	..	1	4	..	2	..	3	..	2§
	+	18	1	..	1	1	1	1	1	..	1	1	..	8
1942-1947	—	41	2	12	6	3	3	1	..	..	..	..	..	5
	+	13	2	1	2	..	..	..	..	..	..	..	..	7
Rectosigmoid colon and rectum														
1937-1942	—	36	..	..	3†	1	1	5	4	3	1	3	..	9
	+	30	2	..	1	1	..	1	2†	2	..	1	..	5
	Not known	3	..	..	..	..	..	..	..	..	..	..	..	2
1942-1947	—	57*	12*†	10	2	6	5	4	..	..	..	..	..	2
	+	22	4	4	4	3	..	..	..	..	..	..	..	4
	Not known	1	..	..	..	..	..	1	..	..	..	..	..	..

* Includes fibromyosarcoma.
† Includes 1 melanocarcinoma.
** One recurrence at six years and 1 at seven years.
§§ One died of pneumonia.
‡ There were two recurrences at five and one-half years, and 1 died at seven years eleven months.
§ One died at five years eight months, after gastrostomy for carcinoma of the esophagus, and 1 died at seven years, cause undetermined.

TABLE 16.—*Follow-Up of Operable Cases in Private Series*

	Lymph Node or Pericolic Involvement	Total	Known to Be Alive and Well (Years)										Died or Had Recurrence
			0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	
Right side of colon														
1937-1942	—	4	..	..	..	..	1	1	..	..	..	1	..	..
	+	1	..	..	..	..	..	..	..	..	..	..	..	..
1942-1947	—	23	2	8	3	2	3	..	..	..	..	..	..	4
	+	13	5	1	1	1	1	..	..	..	..	..	..	4
Transverse colon														
1937-1942	—	0	..	..	..	..	..	..	..	..	..	..	..	..
	+	1	..	..	..	..	..	..	1	..	..	..	..	..
1942-1947	—	13	4	4	1	1	1	..	..	..	..	..	..	2
	+	8	2	2	..	..	..	..	..	..	..	..	..	4*
Splenic flexure														
1937-1942	—	2	..	..	1	1	..	..	..	..	..	..	..	..
	+	0	..	..	..	..	..	..	..	..	..	..	..	..
1942-1947	—	3	..	..	1	1	..	..	..	..	..	..	..	1
	+	2	..	..	..	..	..	..	..	..	..	..	..	2
Descending and sigmoid portions of colon														
1937-1942	—	11	..	..	..	1	1	1	3	..	1	..	1	2
	+	6	..	..	..	..	..	..	2	..	..	..	..	4
1942-1947	—	43	14	13	4	4	2	..	..	..	..	..	..	6†
	+	23	11	2	1	1	1	..	..	..	..	..	..	5
Rectosigmoid colon and rectum														
1937-1942	—	19	1	1	1	..	1	2	2	5	..	..	1	4
	+	8	..	..	..	..	..	1	..	1	..	..	..	6‡
1942-1947	—	69	28	12	8	3	2	1	..	..	..	..	..	14§
	+	39	7	2	5	3	..	1	..	..	..	..	..	21

* One died of coronary thrombosis.
† One died suddenly, cause undetermined.
‡ One died (suicide).
§ Two died of coronary thrombosis, and 1 died of cerebral hemorrhage.

Enlargement of lymph nodes is frequently seen at the time of operation, but this is more likely to be found to be inflammatory. The converse is more often seen with tumors on the left side. It is interesting and heartening to note that of 36 patients in the ward group operated on for cancer of the rectum without involvement of the nodes in the 1937-1942 period 21 are alive and apparently free of disease, three to ten years later. In the same series, of 30 patients with metastasis to lymph nodes, 10 are alive for periods up to ten years. The follow-up studies for cancer in other parts of the colon yield figures which are slightly less promising.

The ward series of patients were operated on by a fairly large group of surgeons, including residents, young surgeons undergoing progressive training and the senior men on this service. During the war years, with a greatly curtailed and frequently inadequately trained staff, the situation was particularly difficult. Many of the deaths in the ward series occurred during this time. We believe that the figures presented constitute what one would find in any good general hospital in this country where operations are being carried out by average surgeons. During the years before the general employment of antibiotics, it was necessary to employ staged procedures and therefore the operation of obstructive resection for neoplasms of the left side was almost routine. We still believe that this is an excellent operation and that it should be taught to every resident surgeon. We are firmly convinced, from our rather extensive experience with this procedure, that as radical an operation can be effected as with the procedure of primary anastomosis.

If one mobilizes the splenic flexure and frees the descending colon from its lateral peritoneal attachments, it becomes an easy matter to remove large sections of the left colon and the accompanying mesentery. The same procedure is carried out when the operation of primary anastomosis is being performed. We are firm in our belief that for the average surgeon it is a much safer operation. If we can teach a large group of surgeons to do a good operation for cancer, with a lower mortality, we should not become exercised about the few extra days the patient must spend in the hospital. It seems to us that too much emphasis is being attached to this question of the time spent in the hospital. We believe that when the therapy of carcinoma is being dealt with the question of the days in the hospital needed to accomplish the surgeon's purpose is unimportant.

SUMMARY

There has been presented in this paper a series of 910 instances of cancer of the colon and rectum. The patients are divided into two comparable groups, one, 549 in number, treated on the ward service and the other, 361 in all, treated as private patients. The marked

difference in the operability rates and the operative mortality of the two groups emphasizes certain statements which were made in previous publications, namely, that there is a vast difference between the type of patient that one encounters in ward practice and the type encountered in private practice, that the private patient seeks aid at an earlier stage in his disease and that the results obtained by spreading out the ward material among a large group of surgeons in various stages of development more correctly approximate the general situation for this type of surgery throughout the country.

The data presented in this paper indicate that the operation of obstructive resection is still an excellent one and should not be discarded in the present wave of enthusiasm for the operation of resection and primary anastomosis. Criteria have been set down on the basis of which the latter procedure seems contraindicated.

Follow-up studies indicate that the greatest number of long term survivors are to be found in the group without lymph node involvement at the time of operation.

PANCREATIC CYST

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IF PANCREATIC cyst were not an uncommon condition, it might be mistaken for carcinoma of the stomach more frequently. During the past twelve years there were 8 cases of pancreatic cyst and 596 cases of carcinoma of the stomach among a total of 160,011 patients admitted to Mercy Hospital, a ratio of 1:75:20,000.

Cysts may be classified into five major groups: (1) developmental —arising on the basis of congenital anomaly; (2) degenerative—the inflammatory-traumatic cyst or pseudocyst, comprising the majority of all pancreatic cysts; (3) obstructive—the small retention or mechanical cyst, the result of obstruction from stone, carcinoma or proliferation of the ductal epithelium; (4) proliferative—composed principally of cystadenoma and cystadenocarcinoma; (5) parasitic—caused by Echinococcus (hydatid).

ANATOMY AND PRESENTATION OF CYSTS

The adult pancreas is an elongated, flattened, wedge-shaped structure lying in the transverse-oblique position in the posterior epigastric and hypochondriac regions. Because of the unyielding nature of the vertebral column and the posterior upper end of the abdominal cage, any cystic mass developing in the pancreas will tend to point anteriorly in the line of least resistance and the symptoms and signs will depend on the size of the mass and the pressure displacement of adjacent organs.

The pancreas is divided regionally into head, neck, body and tail. A cyst arising in the head encroaches primarily on the first and second portions of the duodenum, producing widening of the duodenal loop; with further enlargement it also presses on the pyloric and prepyloric areas of the stomach, the third part of the duodenum and the transverse colon (fig. 1*a*). If the cyst originates in the most lateral (right) portion of the head (fig. 1*c*), the first and second parts of the duodenum may be displaced medially and anteriorly, as occurred in the case reported in detail. A cyst arising in the short neck impinges directly on the posterior wall of the prepyloric region of the stomach

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(fig. 1*b*). If the point of origin is in the body of the pancreas, pressure is created anteriorly on the posterior wall of the middle portion of the stomach via the lesser peritoneal space and in a downward direction on the transverse mesocolon (fig. 1*c*). A cyst located in the tail of the gland displaces the greater curvature of the stomach, the duodenojejunal flexure and the first portion of the jejunum (fig. 1*d*). If large, the proximal loop of the splenic flexure of the colon also may be distorted.

In addition to the size and location of the cyst, much will depend on visceral conditions. Ptosis, obesity, adhesions, age, sex and concomitant or associated disease of other organs are modifying factors.

Cysts of the pancreas often attain considerable size before giving symptoms sufficiently annoying to cause the patient to seek medical

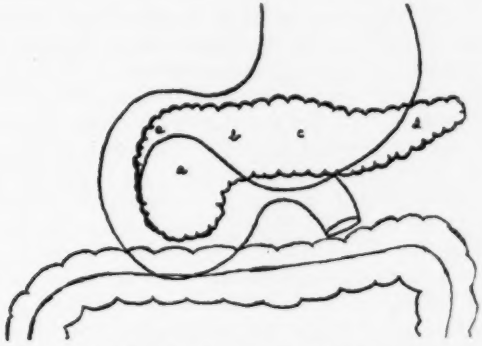

Fig. 1.—Schematic drawing showing relationship of pancreas to surrounding viscera; *a, b, c* and *d* represent head, neck, body and tail of gland. Solid organs have been omitted for simplicity.

attention, and discovery of cysts not sufficiently large to produce pressure symptoms is usually made incidentally at operation or autopsy.

ETIOLOGY

No single common factor serves to explain the etiology of all pancreatic cysts. Development of cysts has to do with the external secretory mechanism of the gland. Whereas other endocrine glands are small and compactly arranged, the pancreas assumes a much elongated shape, and its 12 to 20 cm. length (Borak; Gray) presents a longer duct system susceptible of involvement by disease or injury. In addition, it possesses no true capsule whose resistant quality might serve to confine the increasing pressure of accumulating cystic fluid.

Since degenerative cyst or pseudocyst is the most frequently encountered, as well as the most interesting from an etiologic point of view, three factors which may bear on its development will be considered. These factors are (1) anatomic, (2) inflammatory and (3) traumatic.

No conclusive evidence, clinical or experimental, has proved that obstruction of a main pancreatic duct results in cyst formation (Mahorner and Mattson; Pascucci). Experimental ligation of the main duct has resulted in fibrosis and some dilatation of distal small ducts, but no true cyst has formed (Opie). Likewise, the postulation that fibrosis of the gland results in constriction of main ducts, followed by dilatation of the distal ducts, degeneration of acinar cells and necrosis due to liberated ferments (Dieckhoff; Tilger) remains to be proved experimentally (Pinkham). However, there are considerable anatomic variations in the duct arrangements of the adult pancreatic gland, both within the gland itself and in the relationship of the main pancreatic duct to the common bile duct. Embryologically, the pancreas develops from two distinct portions, the dorsal and ventral, which fuse at about the seventh week of life. The dorsal portion becomes the entire adult gland, with the exception of a part of the head and the main duct (Wirsung's), which are ventral derivatives (Arey; Rienhoff and Pickrell). That such fusion often occurs in an incomplete manner has been emphasized by Rienhoff and Pickrell, who found no functioning connection between the main and accessory pancreatic ducts in 11 per cent and nonpatency of the duodenal opening of the accessory duct in 23 per cent of 100 autopsy specimens. Thus in 34 per cent of their cases secretion could not escape into the duodenum by way of the accessory duct in the event that the main duct was blocked. Such variations may not, in themselves, be responsible for alteration in function to a degree producing clinical symptoms, but when the factor of trauma or inflammation is superimposed, there is greater likelihood of a more severe pancreatitis and perhaps of subsequent development of a cyst.

The anatomic relationship between the main pancreatic duct and the common bile duct has been repeatedly studied as a possible explanation for pancreatitis and its sequelae. These ducts merge above a common sphincter in over 60 per cent of persons (Mehnan; Rienhoff and Pickrell). A more important question, the length of the ampulla compared with the diameter of the common orifice, finds little agreement (Cameron and Noble; Judd; Mann and Giordano; Rienhoff and Pickrell). The fact remains that in a certain number of persons an obstruction at the ampulla of Vater might result in passage of bile into the main pancreatic duct, followed by edema, increased intraductile pressure, breakdown of alveolar elements and pancreatitis. Thus a degenerative

cyst (pseudocyst) may develop as the direct result of inflammation of the pancreas and as the indirect result of an anatomic configuration of the duct systems.

The role of pancreatitis as the chief etiologic agent responsible for the development of pseudocyst has received considerable support (Mahorner and Mattson; Pinkham). Certainly the large, encapsulated, rapidly developing peripancreatic collection containing hemorrhagic fluid, necrotic fat, cellular debris and bits of pancreatic slough cannot be regarded as other than the result of an acute necrotizing pancreatitis. The smaller cystic accumulations, lying within the gland substance or at the periphery and containing clear, mucoid or somewhat turbid fluid, obviously result from a less severe initial process. Recurrent pancreatic edema associated with spasm of the sphincter of Oddi is a suggested cause (Archibald and Kaufmann), but why should one localized area become the site of cystic change? Obstructive metaplasia of the epithelium of smaller ducts has been described (Rich and Duff), which might logically explain a localized inflammation, with acinar coalescence and subsequent degeneration.

The frequency with which demonstrable disease of the biliary tract has been found associated with pancreatitis and degenerative cyst is well known (Archibald and Kaufmann; Judd; Judd, Mattson and Mahorner; Opie; Pinkham). That this association is on a basis of infection is borne out by the fact that in most cases the main pancreatic duct is not obstructed.

The third etiologic factor, trauma, is difficult to evaluate. A history of injury preceding the appearance of a mass in the upper abdominal region is stated to be present in about 20 per cent of cases (Case; Pinkham), but an average of six reported groups (Adams and Nishijima; Judd; Mahorner and Mattson; McWhorter; Rabinovitch and Pines; Takaysu) yields 9.8 per cent. Insistent questioning may lead to unwarranted assumption by the patient and the physician that some trauma sustained in the past is directly responsible for the present illness. However, in certain cases the history of trauma of the upper abdominal region followed within a short time by an enlarging epigastric mass is too definite to be discarded.

The pancreas is soft and relatively flattened and overlies an unyielding vertebral column. A severe blow could conceivably result in a "bursting" of acinar cell groups and destruction of tissue due to enzyme activity, with slow or rapid accumulation of fluid. However, gross traumatic rupture of the pancreas is less common than similar injury of the spleen or liver. It is suggested that when trauma does play a part in the development of degenerative pancreatic cyst, it does so by means

of its effect on a pancreas whose duct system is imperfectly developed embryologically or on a pancreas which is already the seat of a subacute or chronic inflammatory process.

SYMPTOMS AND SIGNS

Pain is the most constant symptom (Adams and Nishijima; Case; Rabinovitch and Pines) reported present in 85 per cent of cases in which no lesion other than the cyst could be held accountable (Judd, Mattson and Mahorner). It is commonly felt in the epigastric and left hypochondriac regions, may radiate to the back, particularly on the left side, and varies in description from a dull ache to an incapacitating colic. The dragging weight of the cyst fluid probably contributes as much discomfort as does the pressure exerted on surrounding organs. Association with intake of food is not usually definite. While the onset may appear to have been sudden in nature, careful questioning may elicit a history of previous milder transitory attacks, often antedating the acute episode by several weeks or months (Rabinovitch and Pines). In some cases there is an insidious beginning, with a history of epigastric fulness, "bloating" or "indigestion" preceding specific pain.

Loss of weight (Benson and Gordon; Case; Judd, Mattson and Mahorner; Rabinovitch and Pines) and weakness (Case; Judd, Mattson and Mahorner) are common complaints. Jaundice is reported in from 7 (Korte) to 18 (Rabinovitch and Pines) per cent of cases and may be due to coexisting disease of the biliary tract rather than to extrinsic pressure by the cyst on the common duct. Nausea and vomiting are mentioned as common (Judd and others; Rabinovitch and Pines) and rare (Case). Foamy, fatty stools, characteristic of cystic fibrosis of the pancreas in children (Kennedy), are not usual in adults.

A palpable mass in the upper abdominal region is the most constant single diagnostic sign (Adams and Nishijima; Bowers and others), detectable in about 95 per cent of cases (Benson and Gordon; Judd and others; Korte). The mass is tense, rounded, relatively nontender, most often in the midline (Korte) or slightly to the left of the midline (Judd and others) in location, and is not particularly movable unless originating in the tail of the gland, when movability in the long axis of the body may be a feature (Benson and Gordon). It may develop rapidly (Case; Takaysu), there may be a long period of gradual increase in size (Benson and Gordon) or a mass known to have been present for some time may suddenly enlarge (Carter and Slattery). Fluctuation in size may be noted (Judd and others), and occasionally a cyst may disappear clinically altogether (Case), presumably when spontaneous drainage occurs into the intestinal tract.

DIAGNOSIS

Consideration of the diagnosis of cyst of the pancreas should be included in a given case on the basis of a palpable mass in the upper abdominal region in or near the midline, coupled with symptoms of pain, loss of weight, weakness and nausea and vomiting. When a pancreatic cyst becomes large enough to produce symptoms, it is also usually large enough to produce a rather typical roentgenographic defect by extrinsic pressure on surrounding organs. Much reliance must therefore be placed on barium examination of the upper gastrointestinal tract. Excellent papers by Case and Borak have emphasized the following roentgen features of diagnostic importance:

1. An extensive, palpable tumor is most likely extrinsic to the stomach.

2. Widening of the duodenal curve is significant of enlargement in the region of the pancreatic head. Exceptions may occur when obesity is present, in cases of relaxed diaphragm with high stomach and in the presence of ascites.

3. Increase in the distance between the vertebral column and the stomach may be apparent in the lateral view.

4. There may be constant filling of the duodenum, which normally is rapidly filled and rhythmically emptied and therefore demonstrable for only short periods.

5. The left side of the diaphragm may be elevated and may show diminished excursion.

6. In the more obese patient a plain roentgenogram of the abdomen may reveal a shadow which by position and relationship to other organs may be identified as a new growth of pancreas.

7. Growths of the pancreatic head usually do not displace the duodenum forward, since both pancreas and duodenum are situated at the same level. (A rare exception to this may occur when a growth or cyst arises in the extreme lateral [right] portion of the head, in which case the first part of the duodenal loop may be displaced medially and anteriorly.)

8. In cysts displacing the lesser curvature of the stomach, the defective shadow has a smooth contour, with the concavity toward the tumor and the edges of the gastric shadow indistinct. Uninterrupted peristaltic waves passing over a suspicious filling defect signify an extrinsic lesion. On application of pressure over the mass or change in position of the patient, the defect alters in shape or disappears.

9. When the cyst originates in the tail of the gland, there is a filling defect of the greater curvature when the patient is prone, with displacement of the greater curvature upward and to the right. This disappears

or alters in shape when the patient stands up. In addition, there may be displacement of the duodenojejunal angle downward, with compression stasis of the third part of the duodenum and poor visualization of the first loop of the jejunum. If the cyst is large, one may see compression and downward displacement of the proximal loop of the splenic flexure of the colon after a barium enema.

10. Calcification of a pancreatic cyst is occasionally seen (McCullough and Sutherland).

Case pertinently stated: "Even when it seems clearly not a lesion of the digestive tube, the roentgen visualization and study of the alimentary tract as a whole may throw important light on the identity of the tumor in question."

Laboratory studies are not of specific aid in establishing the diagnosis. Sustained increase of the blood serum amylase, probably on the basis of associated pancreatitis, may be suggestive of degenerative cyst formation (Pinkham) or of intra-abdominal rupture of cyst (Koucky and others). The serum lipase may exhibit abnormality (Johnson and Lee). While the presence of trypsin (Boyd) or of a markedly increased amylase level (Pinkham) in the fluid content of the cyst strongly suggests pancreatic origin, the detection of starch-splitting enzymes is not held to be positive proof (Boyd; Judd and others; Mahorner and Mattson; Rabinovitch and Pines).

Differential diagnosis should include cyst of the omentum, hydrops of the gallbladder, hydronephrosis, ovarian cyst, cysts or tumors of the liver (Adams and Nishijima; Case; Judd and others); retroperitoneal tumors (Adams and Nishijima; Borak; Judd and others); aortic aneurysm (Borak; Case; Judd and others); mesenteric cyst (Adams and Nishijima) splenic or adrenal tumor or cyst and cysts of the posterior gastric wall (Case; Judd and others) and tumor of the kidney or perinephritic abscess (Ormond and others).

In addition to a history which may suggest disease of the upper part of the gastrointestinal tract, elements in determining the origin of an abdominal mass are its location, size, shape and character, the relationship to surrounding structures on physical examination and roentgenologic studies, signs of disease referable to a specific organ and the presence or absence of movability, tenderness and pulsation. Tumors and cysts arising from retroperitoneal tissues in the pancreatic region or from the left adrenal and cysts of the posterior gastric wall may defy preoperative distinction from pancreatic cyst.

TREATMENT

Complete excision of a pancreatic cyst is the method of choice (Benson and Gordon; Carter and Slattery; Neef and others), but the procedure is possible in only a few cases (Judd and others). Attempted

excision ending in failure carries a 55 per cent mortality (Lahey and Lium). It is successfully accomplished more frequently for cystadenoma (Benson and Gordon) and for the rare dermoid cyst (DeCourcy). It may be anatomically and technically impossible to excise completely the large degenerative cyst (pseudocyst), the anterior wall of which may be composed solely of thin peritoneum of the omental bursa (Held; Pinkham), with a large base blending into most of the pancreatic substance without demarcation of the posterior cyst wall.

Enucleation of a cyst confined to the head of the pancreas presents the problem of injury to the duct of Wirsung or to the accessory duct of Santorini (Lahey and Lium), and fistula formation may occur (Benson and Gordon). The proximity of the common bile duct and the inferior vena cava and the renal veins posteriorly are definite hazards. The serosa of the duodenal loop may blend with the cyst wall after inflammatory reaction, making dissection difficult. Rarely, a cyst located in the pancreatic head may be so masked by associated chronic pancreatitis, with enlargement and hardness to palpation, that an erroneous impression of carcinoma may lead to unnecessary pancreatoduodenectomy (Carter and Slattery).

In cases of cysts of the body and tail of the gland the splenic vein, left renal vein and origin of the superior mesenteric artery may be subjected to surgical trauma. Intimate relationship between splenic vein and cyst wall is not uncommon (Bowers and others). Unusual vascularity of the cyst wall itself may be a feature (Carter and Slattery) prohibiting excision (Babcock and others). When the cyst arises in the tail of the gland the pedicle is often narrow, extirpation is easier and damage to the gland substance is more easily repaired.

Previous external surgical drainage is no bar to attempted excision, success having recently been reported in a case in which eight previous drainages had been done (Carter and Slattery).

If surgical excision is impossible or inadvisable, treatment along lines of internal or external drainage may be carried out. Simple puncture and aspiration of cyst fluid may occasionally give good results (Martin) but is not to be recommended. Lahey favors primary anastomosis between cyst and gastrointestinal tract, and a loop of jejunum would appear to be the site of choice (Adams and Nishijima; Chapman; Chesterman; Hahn). If anastomosis is made between cyst and stomach, it is possible that pancreatic enzymes may in time alter the gastric mucosa, leading to pernicious anemia (Altshuler and Meyers). Physiologically, the gallbladder would seem less desirable than the jejunum and by its relatively fixed position might interfere with subsequent shrinkage of the cyst wall. Internal anastomosis is feasible when the

cyst is solitary and when its wall is of sufficient thickness and quality to withstand suturing. It is contraindicated in cases of multiloculated cystadenoma.

External drainage (Johnson and Lee; Pinkham) or marsupialization followed by treatment of the cyst cavity with sclerosing solutions (Walker) may give good results in cases of degenerative cysts, and the majority of the resulting external fistulas heal spontaneously (Lahey and Lium). However, in certain instances persistent discharge may become a prolonged and troublesome complication (Judd and others; Kerr), and if the fistulous tract heals superficially, there may be subsequent reaccumulation of cyst fluid, which necessitates additional drainage (Carter and Slattery; Mahorner and Mattson; Pinkham). The chronic fistulous tract which refuses to heal after a thorough trial of conservative measures should be transplanted into the jejunum. The mortality for this procedure in competent hands is 3.8 per cent (Lahey and Lium). Roentgenologic visualization of the tract by means of injection of iodized poppyseed oil 40 per cent is a worth while step (Borak), since communication with the main pancreatic duct may preclude healing without transplantation (Lahey and Lium).

Pancreatic cyst of the pseudocyst variety will occasionally perforate into the general peritoneal cavity either spontaneously or after trauma (Koucky and others). The findings are those of perforative peritonitis, and after shock has been combated immediate operation, with marsupialization, is indicated. A cyst has been known to perforate into an adjacent organ such as the stomach, producing a bizarre picture (Pascucci).

Diabetes, usually mild, may accompany cystic disease of the pancreas (Benson and Gordon; Johnson and Lee; Pinkham), occurring in about 6 per cent of cases (Judd and others).

The accompanying table reveals the following significant facts: The majority of the cysts occurred in women, a finding in agreement with other reports (Adams and Nishijima; Benson; Bowers and others; Held; Johnson and Lee; Rabinovitch and Pines). The average age was 48.5 years. Major symptoms in order of their frequency were abdominal pain, loss of weight, nausea and vomiting, "gas," loss of appetite, aversion to fatty foods and sense of fulness. In 6 patients the acute phase of the illness preceding the initial operation averaged 7.2 weeks. Four gave no history of similar previous attacks of abdominal discomfort or digestive difficulty. In none was there a recorded history of trauma. In every case there was a palpable mass. Six were classified as degenerative cysts (pseudocysts) and 2 as multilocular pseudomucinous cystadenomas. In 5 cases the cysts were so large and the pancreas so completely involved that the exact site of origin in the gland could not be determined.

Data on Patients with Pancreatic Cysts

Case	Sex	Age	Principal Symptoms	Duration of Present Illness	History of Previous Attacks	History of Trauma	Abdominal Signs	Preoperative Diagnosis	Operative Findings	Operative Treatment	Complications
1	M	55	Epigastric pain, nausea and vomiting, weight loss (17 lb. [7.7 Kg.]), "gas," fulness and weakness	3 mo.	None	None	Epigastric mass fixed, barely palpable	Carcinoma of stomach	Solitary cyst size of orange in head of pancreas; biliary tract normal	Excision	None
2	F	64	Epigastric pain and soreness; "gas" after meals	1 mo.	None	None	Nontender mass size of grapefruit extending to umbilicus	Abdominal mass of undetermined origin	Cystic pancreas; dark fluid and slough	Drained (5 cigaret drains)	Drained 6 wk.; spontaneous closure
3	F	56	Nausea and vomiting, anorexia and weight loss (26 lb. [11.8 Kg.])	4 mo.	None	None	Smooth, nontender mass extending below umbilicus, slightly movable	Retroperitoneal tumor or pancreatic tumor	Cyst, sloughing pancreas	Marsupialization (cigaret drains)	Drained 9 mo.; spontaneous closure
4	M	31	Pain in left lumbar region for one week followed by epigastric pain for one week	2 wk.	None	None	Large firm mass in upper region of abdomen	Abdominal mass of undetermined origin	Multilocular pseudomucinous cystadenoma	Excision (partial)	Redrainage in 2 and 7 mo.
5	F	50	Pain in upper abdominal area, nausea and vomiting, jaundice and weight loss (amount unknown)	Several weeks	Cholecystectomy and appendectomy 5 yr. prior to this illness	None	Ascites; liver enlarged; tender mass in left upper quadrant	Biliary cirrhosis; common duct obstruction due to stone or tumor; toxic hepatitis and splenitis	(Postmortem) Carcinoma of head of pancreas with metastisis to liver, lungs; large multilocular pseudomucinous cystadenoma of tail of pancreas	Died 11 days after admission; no operation performed	Death due to widespread carcinoma
6	F	40	Abdominal discomfort, vomiting, dyspnea and enlarging abdominal mass	Acute phase, 6 wk.	Vague pain, fulness and occasional vomiting for 12 mo.	None	Large, firm, smooth mass extending down to brim of pelvis on right	Abdominal mass of undetermined origin	Huge cyst filling most of abdomen containing 8,000 to 10,000 cc. brownish yellow fluid	Drained (1 rubber tube)	Redrainage in 1, 12 and 16 mo.; died of adenocarcinoma
7	M	52	Epigastric pain, nausea and "gas," anorexia, weight loss (20 lb. [9.1 Kg.]) and aversion to fats	Acute phase, 4 wk.	Similar attack 13 mo. ago lasting 2 days	None	Slight tenderness in epigastrium; "liver" enlarged 5 fingerbreadths below costal margin	Cystic abdominal tumor of undetermined origin	Cyst containing 800 cc. brownish, thin fluid and gangrenous mass	Removal of slough; cyst packed with gauze	Draining 48 days after operation; no further follow-up obtained
8	F	40	Epigastric pain, "gas," weight loss (22 lb. [10 Kg.]) and aversion to fats	2 yr.	Intermittent epigastric pains after meals for 2 yr.	None	Slightly tender epigastric mass to left of midline	Carcinoma of stomach; cholecystitis; gastritis; duodenitis; pancreatitis	Cyst in tail of pancreas containing 180 cc. of fluid	Evacuated; packed	Redrainage in 2½ mo. and 5 yr.; has drained continuously for past 6½ yr.

Five living patients were personally contacted at intervals varying from one to twelve years after the original operation. Four classified their general health as good and 1 as fair. All have been relieved of their original symptoms. Of four postoperative fistulas, three closed spontaneously and have remained closed for the past three years. The patient in case 8 is a candidate for transplantation of the fistulous tract into the jejunum, since after six and one-half years of constant drainage there is little likelihood of spontaneous closure.

REPORT OF A CASE

J. H., a 55 year old Negro, was admitted to Mercy Hospital on Dec. 8, 1946, with the chief complaints of pain in the upper part of the abdomen, nausea and vomiting, loss of weight and fatigue. Except for influenza in 1918, measles in 1922 and an operation for an inguinal hernia in 1926, he had been in excellent health and had worked as a bricklayer's helper in a local steel mill for nineteen years.

His appetite and digestion had been good all his life, such delicacies as pork chops, pigs feet, chicken neck bones and turnip greens being especially relished. During the midsummer of 1946 he noticed occasional "gas and belching," and in September there was a feeling of fulness after some meals, which was not constant and did not seem to depend on the quantity eaten.

Pain first became manifest late in September. It was located high in the epigastrium and was gnawing in character, with intervals of wavelike colic followed by periods of freedom for two or three days. The pain had no constant relationship to intake of food. At times it was severe enough to "double him up," and it gradually increased in both frequency and severity. He vomited four times during the month prior to his admission, each instance occurring several hours after the previous meal or early in the morning. No food was regurgitated, the vomited material consisting of a small amount of bitter, light brown "juice." His appetite remained good throughout the entire illness. His bowels moved regularly each day, the stools being of solid consistency and brown. Over a period of ten weeks there had been progressive weakness and easy fatigue, with a weight loss of 20 pounds (9.1 Kg.). The remainder of the patient's history was noncontributory.

Physical examination revealed a thin, rather undernourished Negro who appeared chronically ill. Other than borderline hypertension (blood pressure 146 systolic and 90 diastolic), the only remarkable physical finding was a firm, nontender, barely palpable mass lying deep to the midline of the epigastrium and slightly to the right. Its exact size could not be determined with accuracy.

Laboratory studies revealed a red blood cell count of 4,010,000, a hemoglobin content of 78 per cent and a white blood cell count of 7,900. The urine was normal. The phenolsulfonphthalein test showed 65 per cent excretion. The Wassermann reaction was negative. The nonprotein nitrogen was 24.7 mg. and the urea nitrogen 10.2 mg. The prothrombin time was 100 per cent.

Roentgenologic observations of the upper part of the gastrointestinal tract were reported as follows: "The esophagus is normal. There is an ulcerating carcinoma involving the pyloric third of the stomach. There is a palpable mass in relation to the lesion. The lesion appears operable."

On Dec. 13, 1946, the patient's abdomen was opened under spinal anesthesia. The gallbladder, liver, spleen and transverse colon were normal on inspection and palpation. Situated in the head of the pancreas was a rounded, tense, cystic mass of an estimated diameter of 10 cm. It appeared to have originated in the most lateral part of the pancreatic head, since the proximal portion of the duodenal loop was displaced medially and anteriorly, with the serosa intimately adherent to the cyst wall. The pyloric and prepyloric areas of the stomach were pushed upward. After evacuation of the clear, watery content, dissection and removal of the entire cyst wall was possible. During this process no large pancreatic duct was observed, but the common bile duct was inadvertently nicked, necessitating T tube drainage. Bleeding points in the head of the pancreas were controlled with suture and with gelfoam® (absorbable gelatin sponge) and thrombin. Palpation of the stomach failed to reveal an intrinsic mass. The abdomen was closed in layers without drainage other than the tube in the common duct.

Microscopic sections of the cyst wall showed chronic inflammation. There was no epithelial lining.

On the fifth postoperative day the tube in the common duct was dislodged accidentally by the patient and had to be removed. Copious bile-stained drainage gradually diminished, and it ceased on the fourteenth postoperative day. At no time did the drainage cause irritation of the skin. The wound healed primarily, and the patient made an uneventful recovery.

Follow-up studies revealed a negative van den Bergh reaction, a blood sugar content of 107 mg., glucose tolerance fasting 96, 45 minutes 176, two hours 130. The urine reacted negatively to the test for sugar. Roentgenologic study of the upper part of the gastrointestinal tract twenty days after operation revealed: "The pyloric deformity previously described, which had the appearance of a carcinomatous mass in the stomach, has now disappeared. Peristaltic movements and mucosal pattern appear relatively normal throughout the pyloric end of the stomach. The findings are now compatible with the operative diagnosis of pancreatic cyst which previously caused the deformity, and after removal the stomach has resumed normal appearance and function."

The last examintaion, one year postoperatively, found the patient in good health, with normal appetite and no digestive discomfort. He had gained 26 pounds (11.8 Kg.) and was working regularly in the steel mill.

COMMENT

This case is reported in detail in order to emphasize the fact that a cyst located in the pancreatic head can produce a clinical and roentgenologic picture closely simulating primary neoplasm of the stomach. The insidious onset of mild digestive discomfort, followed later by pain, nausea and vomiting, weakness, fatigue and loss of weight, with the presence of a deeply situated, barely palpable mass in the upper abdominal region, might suggest a malignant process. A persistently good appetite, however, is not so common in malignant conditions of the stomach, nor is vomiting without relation to intake of food.

The roentgenologic findings in this case are of particular interest. In the preoperative roentgenograms (fig. 2*A*) there is a constant filling defect in the prepyloric region, at the lesser curvature. This

deformity could not be displaced or made to disappear by palpation or by change of the patient's position during fluoroscopy. There is no marked widening of the duodenal loop and no smooth concavity within this loop. Instead, there is anterior and medial displacement of the first and second portions of the duodenum. Some stasis or "puddling" is evident in the descending duodenal limb. For comparison, figure 2 *B* reveals the condition of the upper gastrointestinal tract twenty days after excision of the cyst. The prepyloric region of the stomach now shows normal filling and mucosal pattern. The first portion of the duodenum has assumed a more normal appearance and position. The stasis of the descending duodenal limb has been relieved.

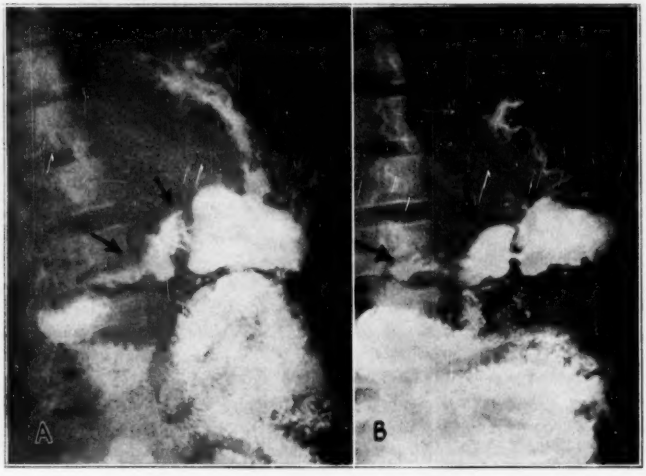

Fig. 2.—*A*, preoperative roentgenogram of stomach showing prepyloric deformity (upper arrow) and location of cyst (lower arrow), with medial and anterior displacement of the first and second portions of the duodenum. *B*, roentgenogram of stomach twenty days after removal of cyst in head of pancreas. Prepyloric defect has disappeared (upper arrow), and the beginning of the duodenal loop has assumed a more normal outline and position (lower arrow).

SUMMARY AND CONCLUSION

1. The salient features of pancreatic cyst are discussed according to classification, anatomy and presentation, etiology, symptoms and signs, diagnosis, surgical treatment and complications. Attention is devoted chiefly to degenerative cyst (pseudocyst).

2. Findings from 8 cases are presented in brief. In 6 the tumors were of the degenerative type, and in 2 they were pseudomucinous cystadenomas. The follow-up status of 5 living patients is included.

3. One of the 8 cases is presented in detail, since the findings clinically and roentgenographically simulated those in cases of neoplasm of the stomach, leading to erroneous preoperative diagnosis. The cyst originated in the lateral margin of the pancreatic head, producing an unusual medial and anterior displacement of the first and second portions of the duodenal loop and a constant prepyloric gastric deformity.

Epigastric pain and a palpable mass in the upper abdominal region are characteristic of pancreatic cyst. Roentgenologic findings are usually confirmatory of an extrinsic gastric lesion. Occasionally, preoperative differentiation from carcinoma of the stomach may be impossible.

BIBLIOGRAPHY

Adams, R., and Nishijima, R. A.: Surgical Treatment of Pancreatic Cysts, Surg., Gynec. & Obst. **83**:181, 1946.

Altshuler, S. S., and Meyers, M. P.: Transgastric Drainage of a Pancreatic Cyst, Followed by Pernicious Anemia, Harper Hosp. Bull. **1**:86, 1942.

Archibald, E. W., and Kaufmann, M., in Lewis, D.: Practice of Surgery, Hagerstown, Md., W. F. Prior Company, Inc., 1944, vol. 7, p. 1.

Arey L. B.: Developmental Anatomy, ed. 3, Philadelphia, W. B. Saunders Company, 1935. pp. 207-208.

Babcock, W. W.; Machteld, E. S., and Gibson, S. B.: Destructive Angiocystic Disease of the Pancreas, Surgery **14**:588, 1943.

Benson, R. E., and Gordon, W.: Cystadenoma of the Pancreas, Surgery **21**:353, 1947.

Borak, J.: Roentgen Examination of Pancreatic Tumors, Radiology **41**:170, 1943.

Bowers, R. F.; Lord, J. W., and McSwain, B.: Cystadenoma of the Pancreas, Arch. Surg. **45**:111 (July) 1942.

Boyd, W.: Surgical Pathology, ed. 6, Philadelphia, W. B. Saunders Company, 1947, p. 352.

Cameron, A. L., and Noble, J. F.: Reflux of Bile Up the Duct of Wirsung Caused by an Impacted Biliary Calculus, J. A. M. A. **82**:1410 (May 3) 1924.

Carter, R. F., and Slattery, L. R.: Factors Influencing the Management of Pancreatic Cysts, S. Clin. North America **27**:411, 1947.

Case, J. T.: Roentgenology of Pancreatic Disease, Am. J. Roentgenol. **44**:485, 1940.

Chapman, C. L. G.: Pancreatic Cyst Treated by Implantation into the Jejunum, Brit. J. Surg. **28**:633, 1940.

Chesterman, J. T.: The Treatment of Pancreatic Cysts, Brit. J. Surg. **30**:234, 1942.

DeCourcy, J. L.: Dermoid Cyst of the Pancreas, Ann. Surg. **118**:394, 1943.

Dieckhoff, cited by Pinkham.

Gray, H.: Anatomy of the Human Body, edited by W. H. Lewis, ed. 24, Philadelphia, Lea & Febiger, 1942, pp. 1218-1224.

Hahn, cited by Adams.

Held, I. W.: Cysts of the Pancreas, M. Clin. North America **24**:855, 1940.

Johnson, T. A., and Lee, W. E.: Pancreatic Cyst: Report of Five Cases, S. Clin. North America **22**:1677, 1942.

Judd, E. S.: Cysts of Pancreas, Minnesota Med. **4**:75, 1921.

Relation of the Liver and the Pancreas to Infection of the Gall Bladder, J. A. M. A. **77**:197 (July 16) 1921.

——Mattson, H., and Mahorner, H. R.: Pancreatic Cysts: Report of Forty-Seven Cases, Arch. Surg. **22**:838 (May) 1931.

Kennedy, R. L. J.: Cystic Fibrosis of the Pancreas, Nebraska M. J. **31**:493, 1946.

Kerr, A. A.: Cysts and Pseudocysts of the Pancreas, with Report of Cases, Surg., Gynec. & Obst. **27**:40, 1918.

Korte, cited by Judd, Mattson and Mahorner.

Cited by Rabinovitch and Pines.

Koucky, J. D.; Beck, W. C., and Todd, M. C.: The Perforation of Pancreatic Pseudocysts, Surg., Gynec. & Obst. **73**:113, 1941.

Lahey, F. H., and Lium, R.: Cure of Pancreatic Fistula by Pancreato-Jejunostomy, Surg., Gynec. & Obst. **64**:79, 1937.

McCullough, J. A. L., and Sutherland, C. G.: Intra-Abdominal Calcification: The Interpretation of Its Roentgenologic Manifestations, Radiology **36**:450, 1941.

McWhorter, G. L.: Cysts of the Pancreas, Arch. Surg. **11**:619 (Oct.) 1925.

Mahorner, H. R., and Mattson, H.: The Etiology and Pathology of Cysts of the Pancreas, Arch. Surg. **22**:1018 (June) 1931.

Mann, F. C., and Giordano, A. S.: The Bile Factor in Pancreatitis, Arch. Surg. **6**:1 (Jan.) 1923.

Martin, H. B.: An Unusual Case of Cystic Disease of the Pancreas, Brit. M. J. **1**:481, 1941.

Mehnan, cited by Case.

Neef, F. E.; Rohdenburg, G. L., and Ritter, S. A.: Cystadenoma of the Pancreas, Am. J. Surg. **46**:377, 1939.

Opie, E. L.: Disease of the Pancreas, ed. 2, Philadelphia, J. B. Lippincott Company, 1910.

Ormond, J. K.; Wadsworth, G. H., and Morley, H. V.: Pancreatic Lesions Confusing Urologic Diagnosis, J. Urol. **48**:650, 1942.

Pascucci, L. M.: Pancreatic Cyst and Lithiasis, Am. J. Roentgenol. **52**:80, 1944.

Pinkham, R. D.: Pancreatic Collections (Pseudocysts) Following Pancreatitis and Pancreatic Necrosis, Surg., Gynec. & Obst. **80**:225, 1945.

Rabinovitch, J., and Pines, B.: Cysts of the Pancreas, Arch. Surg. **45**:727 (Nov.) 1942.

Rich, A. R., and Duff, G. L.: Experimental and Pathological Studies on the Pathogenesis of Acute Hemorrhagic Pancreatitis, Bull. Johns Hopkins Hosp. **58**:212, 1936.

Rienhoff, W. F., Jr., and Pickrell, K. L.: Pancreatitis: Anatomic Study of Pancreatic and Extra-Hepatic Biliary Systems, Arch. Surg. **51**:205 (Nov.-Dec.) 1945.

Takaysu, cited by Koucky.

Tilger, cited by Pinkham.

Walker, H. A.: Pancreatic Cysts, South. M. J. **40**:180, 1947.

NECROSIS OF THE LIVER PRODUCED BY THE COMBINATION OF EXPERIMENTAL HYPERTHYROIDISM AND INFLAMMATION

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IN THE study of the effects of long-standing clinical hyperthyroidism, it has been noted that certain abnormalities of the liver occur. These changes are a decrease in function [1] and, occasionally, alterations in the structure of the liver.[2] The latter manifestation is not frequent, as shown by a recent report from the Massachusetts General Hospital,[3] where no evidence of marked hepatic damage was found in any of the autopsy cases of human hyperthyroidism studied. In the group of 11 cases previously reported from this clinic, severe changes in the liver were seen in only 2.[4]

In investigating this problem in the laboratory, it was noted that experimental hyperthyroidism induced in rabbits with desiccated thyroid produced profound inanition and death without significant alterations in the hepatic structure.[5] On the other hand, if this were complicated by infection, severe changes in the liver resulted.[6] Similar

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1. Youmans, J. B., and Warfield, L. M.: Liver Injury in Thyrotoxicosis as Evidenced by Decreased Functional Efficiency, Arch. Int. Med. **37**:1-17 (Jan.) 1926. Bartels, E. C.: Liver Function in Hyperthyroidism as Determined by Hippuric Acid Test, Ann. Int. Med. **12**:652-674 (Nov.) 1938.

2. Weller, C. V.: Hepatic Pathology in Exophthalmic Goiter, Ann. Int. Med. **7**:543-560 (Nov.) 1933. Beaver, D. C., and Pemberton, J. de J.: The Pathologic Anatomy of the Liver in Exophthalmic Goiter, Ann. Int. Med. **7**:687-708 (Dec.) 1933. Cameron, G. R., and Karunaratne, W. A. E.: Liver Changes in Exophthalmic Goiter, J. Path. & Bact. **41**:267-282 (Sept.) 1935.

3. McArthur, J. W.; Rawson, R. W.; Means, J. H., and Cope, O.: Thyroid Crisis, J. A. M. A. **134**:868-874 (July) 1947.

4. Sealy, W. C.: Role of Infection in the Pathogenesis of Liver Necrosis in Hyperthyroidism, Ann. Surg. **116**:851-859 (Dec.) 1942.

5. Sealy, W. C.: The Induction of Liver Necrosis in Rabbits by the Combination of Experimental Hyperthyroidism and Shope Papilloma, Ann. Surg. **113**:572-578 (April) 1941.

6. Haban, G.: Leberveränderungen bei experimentellem Hyperthyroidismus, Beitr. z. path. Anat. u. z. allg. Path. **95**:579-580 (Sept.) 1935.

findings were obtained by Haban, while McIver [7] showed that in hyperthyroid rats both small doses of chloroform and a low oxygen environment would result in necrosis of the liver. Then it was evident that hyperthyroidism in some way interfered with the normal function of the liver, leaving this structure prone to injury from agents that in the normal animal are tolerated without noticeable anatomic change in it.

TABLE 1.—*Group I. Normal Rabbits Receiving Desiccated Thyroid*

	Days and Amount of Desiccated Thyroid, Gm.	Loss of Weight, Gm.	Survival in Days	Changes in the Liver
3	5 0.512	500	6	0
4	8 0.512	650	6	0
5	9 0.512	725	7	0
6	8 0.512	1,025	7	0
7	9 0.512	500	10	0
8	5 0.512	500	6	0
15	3 0.512	250	4	0
237	21 0.512	825	22	0
238	33 0.128	600	34	0
239	11 0.768	775	11	0
401	6 0.768	400	7	0
403	15 0.768	675	15	0
404	6 0.768	325	7	0
406	6 0.768	725	7	0
409	13 0.768	475	13	0

If, then, infection with virulent hemolytic Staphylococcus aureus results in necrosis of the liver in the hyperthyroid rabbit, it was of interest to know just what factor in infection was capable of causing this change. This then would give information as to the effect of tissue necrosis, bacterial toxins or bacteria on the animal.

7. (*a*) McIver, M. A.: Increased Susceptibility to Chloroform Poisoning Produced in the Albino Rat by Injection of Crystalline Thyroxine, Proc. Soc. Exper. Biol. Med. **45**:201-206 (Oct.) 1940. (*b*) McIver, M. A., and Winter, E. A.: Deleterious Effects of Anoxia on the Liver of the Hyperthyroid Animal, Arch. Surg. **46**:171-185 (Feb.) 1943.

Desiccated thyroid is prepared from beef thyroid and is capable of increasing the metabolism of an animal just as thyroxin. Its action is thought to increase only the oxidation of the cell and is not cytotoxic in any other manner.

To study the effect of the various factors in infection that might result in necrosis of the liver, the toxin of hemolytic Staphylococcus aureus was used. This is a potent bacterial substance and when given intravenously in small amounts causes death immediately. If the toxin

TABLE 2.—*Group II. Normal Rabbits Receiving Staphylococcus Toxin Subcutaneously*

Rabbit	Number of Subcutaneous Injections, Amount and Reaction	Loss of Weight, Gm.	Survival in Days	Changes in Liver	Changes in Kidney
28	15 0.5 cc. ++++	450	16	0	0
29	4 0.5 cc. ++++	450	5	0	0
35	8 0.5 cc. ++++	400	8	0	0
4C	6 0.5 cc. +++	350	7	0	0
8C	16 0.25 cc. +++	50	17*	0	0
16C	5 0.25 cc. ++	200	6	0	0
18C	7 0.25 cc. ++	50	8*	0	0
19C	7 0.25 cc. ++++	400	8	0	0
20C	7 0.25 cc. ++	50	8*	0	0

* These rabbits were killed.

is diluted further and the animal allowed to survive a few hours, pronounced necrotizing tubular and glomerular changes in the kidneys occur.[8] When the smaller doses are given, the animal may survive, and the renal lesions will eventually heal. The liver, except for occassional areas of fatty infiltration and hemorrhage, is not involved in this process.[8]

When staphylococcus toxin is injected subcutaneously, widespread local necrosis of the skin occurs. The effect on the animal of a single injection, other than a local change, is not marked. The injections can

8. Rigdon, R. H.: Some of the Experimental Lesions Produced by Staphylococcus Toxin, South. M. J. **32**:798-802 (Aug.) 1939.

be repeated daily until the animal succumbs from the severe sterile necrosis of the subcutaneous tissue.

In this experiment normal stock rabbits of 1,800 to 2,500 Gm., fed on a balanced ration, were divided into five groups. Group I was composed of normal rabbits given 0.512 to 0.768 Gm. of desiccated thyroid per day until death ensued (table 1). The steady loss of weight was the only important change observed in the animals before death.

TABLE 3.—*Group III. Hyperthyroid Rabbits Receiving Staphylococcus Toxin Subcutaneously*

Rabbit	Days and Amount of Desiccated Thyroid, Gm.	Number of Subcutaneous Injections, Amount and Reaction	Loss of Weight, Gm.	Survival in Days	Changes in Liver	Changes in Kidney
30	4 0.768	2 0.5 cc. ++++	425	1½	0	0
31	5 0.768	3 0.5 cc. ++++	325	4	++	0
32	4 0.768	2 0.5 cc. ++++	275	1½	0	0
34	6 0.536	4 0.5 cc. ++++	575	5	++++	0
37	4 0.536	3 0.5 cc. ++++	525	3	++++	0
38	4 0.768	3 0.5 cc. ++++	350	4	+++	0
39	4 0.536	3 0.5 cc. ++++	525	3	++++	0
40	4 0.536	3 0.5 cc. ++++	325	4	++++	0
2C	4 0.768	3 0.5 cc. ++++	450	4	++++	0

In group II were rabbits that were given only daily subcutaneous injections of potent hemolytic Staph. aureus toxin supplied by the Lederle Laboratories (table 2). The animals received 0.25 to 0.5 cc. of this toxin in the subcutaneous tissue of the back. This produced a severe diffuse inflammatory reaction in the subcutaneous tissue that involved the skin of the back and abdomen. Repeated injections caused massive necrosis, with mummification of the abdominal skin. Eventually death occurred in most animals, apparently from the massive necrosis in the subcutaneous tissue.

In group III were normal rabbits given desiccated thyroid, and then forty-eight hours later subcutaneous injections of staphylococcus toxin was started as in group II (table 3).

TABLE 4.—*Group IV. Hyperthyroid Rabbits Receiving Staphylococcus Toxin Intravenously*

Rabbit	Days and Amount of Desiccated Thyroid, Gm.	No. of 1 Cc. Intravenous Injections of Staphylococcus Toxin Dilution	Loss of Weight, Gm.	Survival in Days	Changes in Liver	Changes in Kidney
9	8 0.768	7 1:20	750	4	0	+
13	3 0.768	2 1:40	320	3	0	+
14	19 0.768	14 1:40	1,000	15	0	+
1B	4 0.768	1 1:10	275	8 hr.	0	+++
2B	4 0.768	1 1:10	250	1	0	+++
3B	5 0.768	2 1:10	375	1¼	0	++++
10B	12 0.768	5 1:20	1,000	8	0	+
11B	12 0.768	5 1:20	800	7	0	+
13B	7 0.768	3 1:10	750	4	0	+++
14B	10 0.768	7 1:10	1,050	7	0	+
20B	4 0.768	2 1:10	250	2	0	++

TABLE 5.—*Group V. Normal Rabbits Receiving Staphylococcus Toxin Intravenously*

Rabbit	No. of 1 Cc. Intravenous Injections of Staphylococcus Toxin Dilution	Loss of Weight, Gm.	Survival in Days	Changes in Liver	Changes in Kidney
1	8 1:10	0	12	0	++
11	9 1:20	0	10*	0	++
12	8 1:20	0	9*	0	+
17	2 1:10	0	2	0	+++
4B	7 1:10	0	8*	0	++
8B	4 1:10	0	5	0	++
16B	1 1:10	0	8 hr.	0	++++
17B	1 1:10	0	8 hr.	0	++++
18B	1 1:10	0	8 hr.	0	+++

* These rabbits were killed.

Group IV was composed of normal rabbits given dilutions of Staph. aureus toxin intravenously that varied in concentration from 1 to 10 to 1 to 100. The dilutions were carried out in isotonic sodium chloride solution, and the injections were given immediately after preparation of the solution. The rabbits varied somewhat in their response to the toxin. A 1 to 10 dilution produced a profound toxic reaction and immediate death in about one half of the animals (table 4).

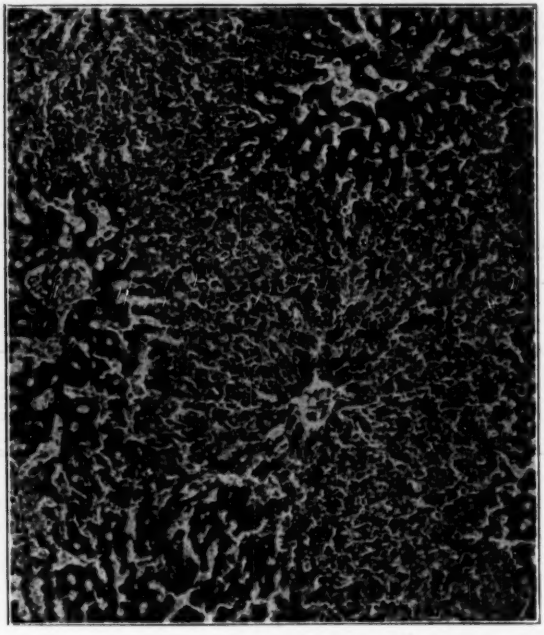

Fig. 1.—Section from the liver of rabbit no. 40 showing extensive central and focal necrosis resulting from hyperthyroidism and inflammation of the subcutaneous tissue.

Group V was composed of normal stock rabbits given desiccated thyroid by mouth forty-eight hours before intravenous injection of the toxin of hemolytic Staph. aureus was started just as in group IV (table 5).

Complete autopsies were done on all animals. Sections were fixed in both Zenker's solution and 10 per cent formaldehyde and subsequently stained with hematoxylin and eosin.

In group I, in which only desiccated thyroid was administered, no significant changes were produced in the liver. In group II the repeated

injections of subcutaneous staphylococcus toxin, though causing death, did not result in any morphologic changes in the liver. In group III, however, in which both toxin subcutaneously and thyroid were given, 7 of the 9 animals showed necrosis of the liver. The rabbits without change in the liver died thirty-six hours after the subcutaneous administration of toxin was begun.

The necrosis of the liver seen in group III was striking. It involved focal and central areas of the liver lobule, and caused complete disintegration of the cells in exactly the same manner as that described in

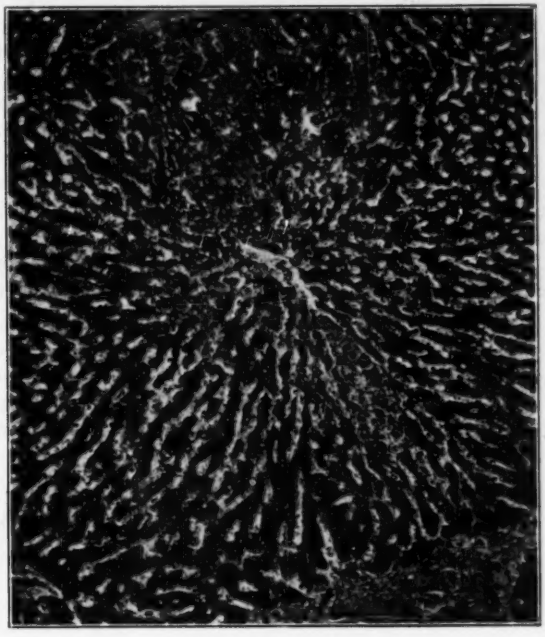

Fig. 2.—Section from the liver of rabbit no. 31 showing a small area of central necrosis resulting from hyperthyroidism and inflammation.

previous papers.[9] In addition, there was marked infiltration of the areas with acute inflammatory cells. Figures 1 and 2 show representative sections from this group.

In groups IV and V, in which both the animals fed thyroid and normal rabbits were given varying amounts of the staphylococcus toxin intravenously, no changes in the liver resulted. However, the typical changes in the kidneys were seen, as has been described in other reports.[7b]

9. Footnotes 4 and 5.

From those experiments it is evident that the toxin of hemolytic Staph. aureus is not capable of producing significant changes in the liver of the normal or hyperthyroid rabbit. Massive doses of desiccated thyroid alone will not produce changes in the liver. On the other hand, when massive subcutaneous inflammation and necrosis induced by staphylococcus toxin are combined with experimental hyperthyroidism, necrosis of the liver ensues.

The effect of toxic substances produced by the destruction of the animal's own tissue is not well understood. It is a common clinical observation that patients with a chronic infection or a large necrotic tumor become toxic. The reason for this progressive debilitated state is not known. It is considered that the effect of thyroxin on the liver and other cells is nonspecific, only causing a notable increase in cellular metabolism. Then perhaps the hyperthyroid animal can be used for localizing the effect of certain poorly understood toxic substances. A similar occurrence was demonstrated in the myocardium by Schultz [10] using streptococcic infection in hyperthyroid guinea pigs. One may postulate that the presence of necrotic tissue has a definite effect on the liver that does not manifest itself as morphologic changes in hepatic cells of animals with a normal metabolism; but in hyperthyroidism the liver is markedly vulnerable to the toxic substance elaborated by necrotic tissue.

CONCLUSIONS

Sterile inflammation of the subcutaneous tissue of hyperthyroid rabbits induced by staphylococcus toxin causes necrosis of the liver. The intravenous administration of staphylococcus toxin to hyperthyroid rabbits does not produce changes in the liver.

10. Schultz, N. P.: The Induction of Carditis by the Combined Effects of Hyperthyroidism and Infection, Pub. Health Rep. **54**:1205-1228 (July) 1939.

REPAIR OF ANTERIOR SUBCOSTOSTERNAL HERNIA OF THE DIAPHRAGM (HERNIA OF MORGAGNI) USING A FLAP OF TRANSVERSALIS FASCIA

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ALTHOUGH diaphragmatic hernia in general has ceased to be a rare disease, the anterior subcostosternal type (i. e., through the foramen of Morgagni) is unusual. Hedbloom [1] stated that about 60 poorly documented cases had been described up to 1938 in a study of 1,003 diaphragmatic hernias of all types. Harrington [2] pointed out that 24 instances were reported between 1930 and 1942. Only 5 patients had undergone surgical treatment. In his own series of 270 diaphragmatic hernias there were 4 of the subcostosternal type operated on. In a later article [3] the same author added 4 more cases of this type, which made a total of 8 in his personal experience with 404 diaphragmatic hernias.

Subcostosternal hernias or hernias through the foramen of Morgagni have been classified as congenital and acquired. As stressed by Harrington, the constant location of the hernial hiatus, the constant relation of the neck of the sac to the round and falciform ligaments of the liver and the occasional association of the condition with nonrotation of the right side of the colon all suggest an embryologic malformation. The presence of a peritoneal sac indicates that the abdominal cavity has been invested by peritoneum prior to herniation of the abdominal organs. The condition therefore occurs relatively late in fetal life.

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1. Hedbloom, C. A.: Ann. Surg. **94**:776-785 (Oct.) 1931.
2. Harrington, S. W.: Surg., Gynec. & Obst. **73**:601-614 (Nov.) 1941.
3. Harrington, S. W.: Ann. Surg. **122**:546-568 (Oct.) 1945.

Though probably congenital in origin, the subcostosternal hernia is found most often in later life, probably because of increased intra-abdominal pressure exerted against a congenitally weak point in the diaphragm. Donovan [4] reported finding the hernia in a 16 month old male infant who had symptoms at the age of 2 months and also in a 12 year old boy. The majority of instances have involved adults, with no particular sex preponderance.

In the normal person, weak areas in the diaphragm are found in the subcostosternal spaces of Larrey. These triangular spaces are bounded

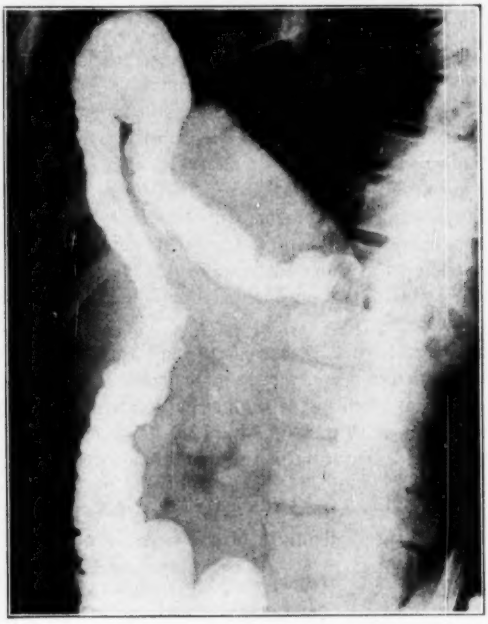

Fig. 1.—Preoperative barium enema showed the transverse colon in the hernial sac.

by the sternal portion of the diaphragm medially, laterally by the costal portion of the diaphragm near the seventh costal cartilage and anteriorly by the sternum. The spaces are occupied by areolar and connective tissue with a covering of pleura and pericardium superiorly and peritoneum inferiorly. Occasionally, the sternal attachment of the diaphragm is entirely absent and the two spaces of Larrey fuse into a large defect behind the sternum and the neighboring costochondral junctions. The following case is illustrative of this type of hernia.

4. Donovan, E. J.: Ann. Surg. **122**:569-581 (Oct.) 1945.

REPORT OF A CASE

H. T., a 29 year old white carpenter and World War II veteran, was admitted to the hospital on March 3, 1947, complaining of easy fatigability of one year's duration and chronic nonproductive cough of two year's duration. The patient stated that he had noted occasional pain in the right lower region of the chest. Since discharge from the Army in November 1945 he had gained 35 pounds (15.9 Kg.) and had noted fulness of the neck. He stated that he had felt borborygmi in the right side of the chest but had no other gastrointestinal symptoms.

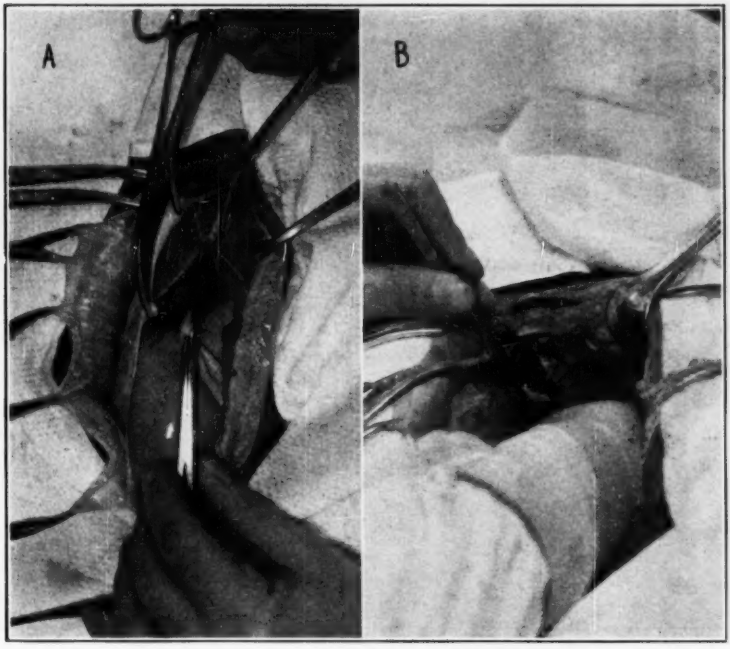

Fig. 2.—*A*, the round ligament is divided close to the liver in a cadaver. The transversus muscle flap is developed and turned back to the right. *B*, the left lobe of the liver is mobilized in a cadaver and retracted inferiorly, revealing a defect in the diaphragm.

He reported to the outpatient clinic with these complaints, where a diagnosis of hernia through the foramen of Morgagni was made after a routine roentgenogram of the chest. He was referred to the hospital. The past history was noncontributory except for surgical drainage of the right knee in 1940, which the patient thought was tuberculous.

Physical examination revealed that there was no enlargement of the thyroid. There were slight dulness and impaired transmission of breath sounds over the

lower right anterior region of the chest. Deep pressure in the right upper quadrant caused some pain in the lower right anterior part of the thorax. Examination of the right knee showed two healed operative scars.

Laboratory and Roentgenologic Data.—Examinations of the blood and urine gave results which were within normal limits. The reaction of the blood to the Mazzini test was negative. The sedimentation rate and the basal metabolic rate were normal. The roentgenogram of the chest (fig. 1) showed an ovoid mass containing gas-filled loops of bowel lying in the lower right region of the chest anteriorly, immediately above the diaphragm and to the right of the midline. A

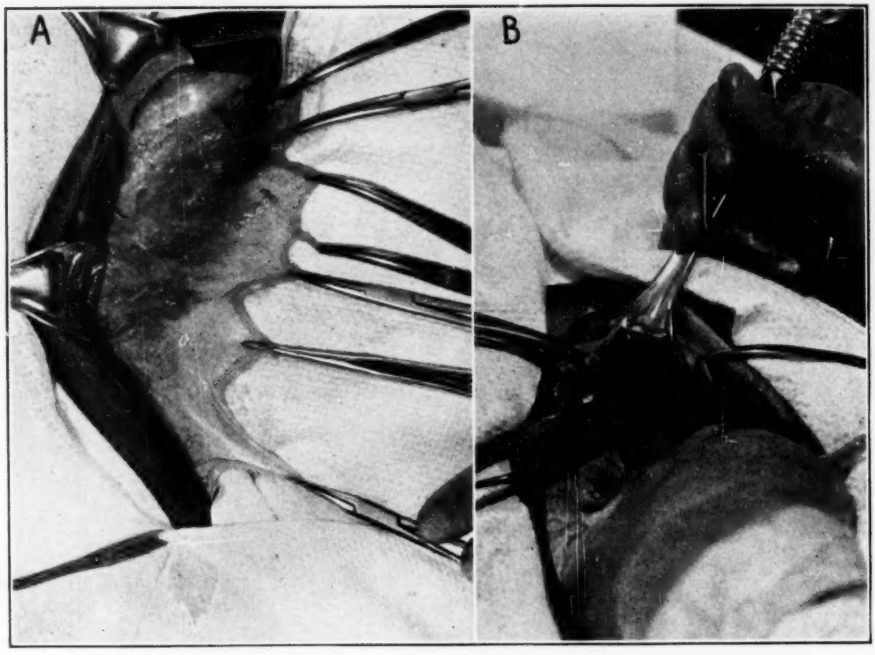

Fig. 3.—*A*, the lateral half of the right rectus muscle in a cadaver is retracted to the right, revealing the posterior sheath of the rectus and transversus muscles. *B*, The flap developed from the posterior sheath of the rectus and transversus muscles in a cadaver is swung upward and inward to effect the repair.

barium enema showed these to be loops of mid-transverse colon. A barium meal revealed no abnormality of the upper part of the gastrointestinal tract.

Exploration was performed through a right rectus incision, and a hernia in the foramen of Morgagni was found which contained a loop of transverse colon and omentum. When the viscera were reduced, the sac measured about 3½ inches (8.89 cm.) in depth, and its mouth measured 3 inches (7.62 cm.) transversely and 1½ inches (3.81 cm.) in the anterior-posterior diameter. There was no sternal attachment of the diaphragm. The round and falciform ligaments

of the liver formed the right lateral border of the mouth of the sac. The diaphragmatic defect was repaired with a sliding flap of the transversus abdominis. Because this is believed to be the first clinical application of this method, it will be described in detail.

The round and falciform ligaments were divided as close to the liver as possible and swung downward, their attachments to the abdominal wall being preserved (fig. 2*A*). No attempt was made to remove the peritoneal sac because of possible damage to the pericardium, which could be seen through the dome of

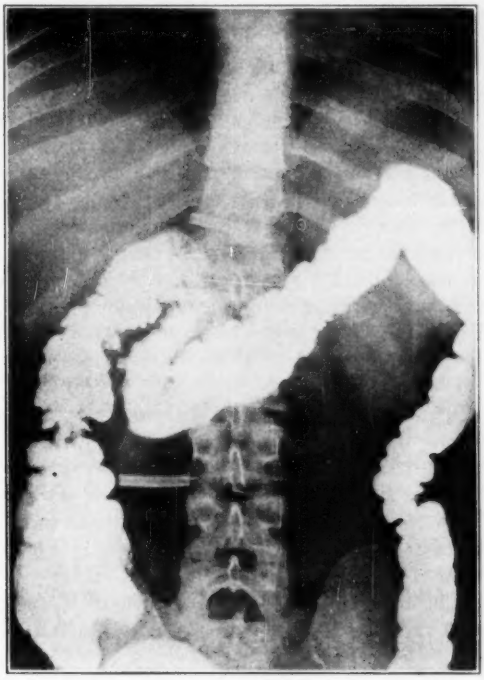

Fig. 4.—Postoperative barium enema showed complete reduction of the transverse colon.

the sac (fig. 2*B*). The peritoneum was excised from the rim of the hiatus, and the cut posterior free edge was sutured to the left leaf of the peritoneum of the anterior abdominal wall, the upper angle of the abdominal incision thus actually being closed. The right leaf of the transversus abdominis was dissected from its attachment to the xiphoid process and right costal cartilages and mobilized from the rectus muscle anteriorly and peritoneum posteriorly (fig. 3*A*). A flap was thus formed which was swung to the left and upward and sutured to the posterior rim of the diaphragmatic hiatus (fig. 3*B*). (The anterior rim was formed by the posterior surface of the sternum and the neighboring costal car-

tilages.) Since the defect was relatively small, it was possible to imbricate the flap of transversus adbominis muscle over the defect in order to reenforce the repair. The round and falciform ligaments of the liver were swung up and used to reenforce the upper angle of the closure of the peritoneum of the abdominal wall. The rest of the abdominal wall was then closed in layers. The left leaf of the transversus abdominis was sutured to the base of the flap on the right in order to close the upper angle of the muscle layer of the abdominal wall. The remaining closure was accomplished in a routine manner. Interrupted sutures of silk were used throughout. The repair was completed without tension. The patient made an uneventful recovery. A postoperative barium enema revealed a successful repair of the hernia (fig. 4).

COMMENT

The symptoms of hernias of this type may be mild or severe. Often they mimic those of disease of the gallbladder, pancreatitis, peptic ulcer or intestinal obstruction. Disturbances in the chest, however, are probably the most common presenting symptoms and have prompted surgeons to explore these lesions through the chest. Cough, dyspnea and precordial pain may be attributed to mechanical interference with respiration. Borborygmi in the chest may be experienced by the patient. On physical examination dulness or tympany may be elicited by percussion over the lower anterior region of the chest, depending on the absence or presence of gas-filled loops in the hernial sac Borborygmi may be heard, and succussion sounds synchronous with the heart beat have been reported rarely.

The typical roentgenologic findings in hernias through the foramen of Morgagni have been reported by Ritvo and Peterson.[5] There usually is a rounded density with sharply defined borders extending from the heart shadow laterally even as far as the anterior axillary line. In the lateral view, the mass occupies the anterior and middle portions of the right lower pulmonary field and the sharp upper border blends into the shadow of the anterior wall of the chest. There may be atelectasis of the right middle lobe. The mass cannot be separated from the right border of the heart shadow, but it does not pulsate. Pericardial celomic cysts may be difficult to distinguish from a diaphragmatic hernia of this type even after careful fluoroscopy. Pneumothorax will usually help to separate the outline of the cyst from the contour of the diaphragm. If bowel loops are present in the hernia, intestinal patterns are seen which are, of course, pathognomonic. On the other hand, fluid levels may be present in the bowel which may give the erroneous impression of encapsulated pleural fluid or pulmonary abscess. The differential diagnosis between eventration of the diaphragm and hernia in the foramen of Morgagni may be difficult. However, fluoroscopic studies

5. Ritvo, M., and Peterson, O. S., Jr.: Am. J. Roentgenol. **52**:399-405 (Oct.) 1944.

of the former lesion may show diminished or even paradoxic movement of the diaphragm, and oblique and lateral views will usually reveal the entire unbroken contour of the diaphragm. At any rate, pneumoperitoneum or pneumothorax will help to establish the diagnosis in most instances.[6] In any event, a patient with a mass in the anterior lower pulmonary field or the inferior mediastinum which is rounded and has sharply defined borders should be given a barium meal and barium enema to aid in establishing the diagnosis. At operation, usually transverse colon and omentum are found within the sac. Omentum, ascending colon, cecum, appendix and the terminal portion of the ileum have also been found. Even when the sac contains omentum alone, one may suspect subcostosternal diaphragmatic hernia because of the presence of a highly situated gas pattern in the large bowel seen in the right lateral view of the chest. Since the abdominal approach to the hernia is preferable to the thoracic approach, it is imperative to make the correct diagnosis preoperatively.

The diaphragm develops from many components, most important of which are the septum transversum which contributes the ventral portion, the pleuropericardial membranes which form the lateral segments and a median dorsal segment derived from the dorsal mesentery. In addition to these three main anlages, the diaphragm acquires an additional rim of tissue from the abdominal wall during its development.[7] For purposes of discussion it is proper to consider the diaphragm as being continuous with the transversus abdominis muscle anteriorly and the lumbodorsal fascia posteriorly. Caspar Bartholin (1676) advanced such a theory, and he described the diaphragm and the transversus abdominis as a continuous muscular sheet which he called the trigastric muscle. In an excellent anatomic study Rives and Baker[8] recently showed that the transversus abdominis was continuous with the diaphragm at the costochondral insertion anteriorly, and they suggested the use of the former muscle in the repair of anterior defects of the diaphragm. Essentially, their method was used in the case described here.

Rives and Baker described the use of a sliding fibromuscular flap in the treatment of a large posterior diaphragmatic hernia. In their case a sliding flap was constructed from the latissimus dorsi muscle. Chisholm[9] in a later article described the fate of latissimus dorsi muscle flaps used to obliterate defects made in the diaphragm of a dog. The flap began to atrophy after the fifth month, and the remaining diaphragm

6. Bisgard, J. W.: J. Thoracic Surg. **16**:484-490 (Oct.) 1947.

7. Arey, L. B.: Developmental Anatomy, ed. 4, Philadelphia, W. B. Saunders Company, 1940.

8. Rives, J. D., and Baker, D. D.: Ann. Surg. **115**:745-755 (May) 1942. Rives, J. D.: Surg., Gynec. & Obst. **74**:1026-1028 (May) 1942.

9. Chisholm, T. C.: J. Thoracic Surg. **16**:200-206 (April) 1947.

stretched in order to fill in the defect. Histologic sections of the latissimus dorsi used in the flap showed early fatty degeneration and replacement fibrosis. At eleven months after operation the function of the diaphragm was unimpaired and the hernia apparently repaired.

This is the first recorded instance of the use of a fibromuscular flap in the repair of an anterior defect of the diaphragm. This operative procedure can be used to close much larger defects of the diaphragm without tension. For large defects it may be advantageous to paralyze the phrenic nerve in the neck. However, Chisholm pointed out that he was able to repair large defects in dogs without resorting to such a procedure. In effect, the technic described employs a pedicle flap of tough fascia and muscle with an intact blood and nerve supply which continues to function many months after operation. The method is especially advantageous when the retrosternal portion of the diaphragm is absent. Since the repair is an extraperitoneal one, the intestines do not interfere with the exposure. It is preferable to the use of a free graft of fascia or of fascial sutures, which have not proved universally successful.

The fact that the peritoneal sac is left behind presents no problem. A postoperative roentgenogram of the chest of this patient revealed a fluid level in the hernial sac which disappeared gradually in subsequent roentgenograms. A fluid level is of no clinical significance and should not lead one to the erroneous impression that the hernia has recurred.

SUMMARY

A case of diaphragmatic hernia through the foramen of Morgagni is presented. A method of repair using a flap of transversus muscle has been employed in a clinical case for the first time.

PROGRESS IN ORTHOPEDIC SURGERY FOR 1946

A Review Prepared by an Editorial Board of the American Academy of Orthopaedic Surgeons

XX. CONDITIONS INVOLVING THE SPINE AND THORAX, EXCLUSIVE OF THOSE IN THE LOWER PART OF THE BACK

Prepared by

JOHN R. COBB, M.D.

NEW YORK

RETRACTOR FOR SPINAL SURGERY

TAYLOR [1030] describes a simple retractor for spinal surgery. The advantages are derived from the principle of leverage. The important feature is a small tip, 3/8 inch wide (0.95 cm.), 1/2 inch (1.27 cm.) long and curved slightly forward at the end of the retracting blade. The tip is caught on the lateral surface of the articular facet on which leverage is made for retraction.

[ED. NOTE.—This retractor has definite advantages when the articular facets are to be arthrodesized.]

TREPHINEMENT

Michele and Krueger [1031] describe a method of trephining vertebral bodies:

A paravertebral incision is made directly over the articular facet of the vertebral body under diagnosis. The articular facet is located and the intra-articular space is gouged at a right angle, with the trephine entering into the medullary space of the pedicle. . . . The dense cortical rim of the vertebral body and of the pedicle will prevent the trephine from penetrating outside its margin. . . .

Aside from removal of the pathological tissue through the area of trephining, . . . a complete excochleation of the cancellous vertebral body can be performed with replacement by iliac graft. . . .

The question of conservative or operative treatment for spinal tuberculosis, with a beginning collapse, has thus been decided. Spinal fusion is modified by replacing pathological tissue with osteogenetic graft.

[ED. NOTE.—Any biopsy of a vertebral body is not without some danger, and it is questionable whether it should be done except in rare cases. One wonders whether it is desirable to communicate with a tuberculous abscess in front when one wishes to get a solid spinal fusion behind.]

1030. Taylor, G. M.: A Simple Retractor for Spinal Surgery, J. Bone & Joint Surg. **28**:183-184 (Jan.) 1946.

1031. Michele, A. A., and Krueger, F. J.: Vertebral Body Trephine: Preliminary Report, Pub. Health Rep. **62**:1166-1167 (Aug.) 1947.

DISEASES OF INTERVERTEBRAL DISKS

Rupture.—Echols [1032] discusses radicular pain due to ruptured cervical disk. He classifies the several types of ruptured cervical disk according to the neural structures which they compress:

> Cervical intervertebral disks which rupture into the spinal canal may produce no neurologic symptoms if the hernia is small, may merely compress a single nerve root if the nodule is small and laterally placed, may result in compression of the spinal cord and one or both adjacent nerve roots if the protrusion is large, or may compress the cord alone if the hernia is discrete and near the midline.

In reviewing the literature, the author found less than 75 reported cases of ruptured cervical disk producing compression of the cord. He points out, however, that the literature certainly does not give a true picture of the incidence, and that probably every neurosurgeon has a collection of unpublished case reports. He states:

> The points of maximum pain are the base of the neck, the tip of the shoulder and the upper arm. The pain may extend into the hand and fingers but paraesthesias, including a feeling of numbness in the hand and fingers, are usually the chief complaints referable to areas below the elbow. These sensations of numbness in case of the disk below the sixth body (seventh root) are experienced chiefly in the index finger and often in the thumb and middle fingers as well. The triceps muscle may be weak and its tendon reflex may be diminished or absent. In case of the disk below the fifth body (sixth root) the numbness is slight and chiefly in the thumb and first metacarpal. The biceps muscle is weakened and its tendon reflex is decreased.

Firm pressure on the back of the neck close to the midline, says the author, may increase the radicular pain. A positive reaction to the test for foraminal compression, which consists of tilting the head toward the painful side and applying pressure on the top of the head, is almost pathognomonic. He continues:

> Seventh Cervical Disk: Rupture of the lowest cervical disk (below the seventh body) has been reported only 10 times. . . . It may be that some of the atypical cases of scalenus anticus syndromes with pain and paresthesia in the ulnar distribution are really cases of compression of the eighth cervical root by rupture of the seventh disk.
>
> Sixth Cervical Disk: The sixth cervical disk is the one which ruptures most frequently. . . . compression of the seventh cervical root . . . produces numbness and sometimes pain in the index finger and sometimes in the thumb and middle finger as well. Most of the pain is in the neck, thorax, scapula, shoulder, posterolateral surface of the upper arm, and dorsum of the forearm.
>
> [Rupture of the fifth cervical disk] produces sensory changes chiefly in the thumb and first metacarpal region. The biceps muscle may be weak and its reflex may be absent. The pain is felt along the radial aspect of the arm and forearm.

1032. Echols, D. H.: Radicular Pain Due to Ruptured Cervical Disk, South. Surgeon **12**:205-218 (Oct.) 1946.

The author states that except for 3 cases listed in an article by Young, clear examples of rupture of the fourth cervical disk have not been reported. Anatomically, the pain and paresthesia should be in the neck, shoulder and arm.

Lateral rupture of the disk below the third body has not been reported. Rupture of this disk would presumably produce pain in the side of the neck and in the clavicle, supraspinatus region, and shoulder tip.

It is possible that some cases of chronic occipital neuritis are caused by a ruptured second disk. Young mentions a case of rupture of the disk below the second body which was proved by myelography and at autopsy. The patient had stiffness of the neck followed by pain in the side of the neck and elevation of the tongue, presumably because weakened infrahyoid muscles failed to fix the hyoid bone.

Roentgenologic findings are of great assistance in the differential diagnosis of pain in the neck, shoulder, and arm, but can be misleading. Probably the most constant finding . . . is loss of the normal curvature. . . . Roentgenographic evidence of narrowing of a disk is a useful finding provided it is the disk which the examiner believes, on clinical grounds, to be ruptured.

Ruptured thoracic disk will in time be considered in the differential diagnosis of chronic thoracic and abdominal pain, including the so-called intercostal neuritis.

The author reports 18 cases, recorded in a period of five years, of protruded cervical disk producing radicular syndrome, with operation in only 3. Operation was performed after conservative orthopedic measures had failed. Similar findings were reported by Elliott and Kremer, while Young reported 56 cases, in only 5 of which was surgical treatment given.

[Ed. Note.—This is a good article; it emphasizes the importance of careful neurologic examination in cases of pain in the neck, arm and back, and the importance and efficacy of conservative treatment. It should be read in its entirety.]

Protrusion.—James [1033] discusses protruded cervical intervertebral disk as a cause of brachial neuritis. Believing that even at the time of his report the literature gave a poor idea of the incidence of this common condition, he states:

When discs protrude posteriorly the protrusion is most often laterally, as the posterior longitudinal ligament is thick in the mid-line and thinner at each side where it lies over the intervertebral disc. Mid-line protrusions do occur and may cause a paraplegia. Large lateral protrusions may compress the cord and produce a Brown-Séquard syndrome but the great majority of protrusions are farther lateral and compress the nerve root against the lamina, ligamentum flavum or articular facet. In the cervical region one damaged disc compresses one nerve root but it is possible to have more than one disc affected. . . . In the

1033. James, E. S.: Protruded Cervical Intervertebral Discs: A Cause of Brachial Neuritis, Canad. M. A. J. **55**:139-142 (Aug.) 1946.

lower lumbar region . . . it is possible for one protrusion to compress more than one nerve root because of their oblique descent in the spinal canal.

Most of these cases are in people past 40 years of age and no history of trauma can be obtained. Trauma, however, is a factor in young people. . . . Degeneration of connective tissue is responsible for the vast majority of cases. . . . Occasionally a history of a similar attack in the opposite arm will be obtained.

Probably all cases of the scalenus anticus syndrome are due to protruded cervical discs. [ED. NOTE.—This is probably a little too inclusive.]

Osteo-arthritis of the cervical spine has been a frequent diagnosis, suggested by the radiologist and readily accepted by the clinician. It is pointed out that the narrow disc is incidental and the nerve roots are either compressed by osteophytes or by a narrowing of the intravertebral foramina. Osteo-arthritis in the lumbar spine is not accepted as the cause of sciatica. Nature looks after her nerves and must very rarely if ever allow bony overgrowths to encroach on them. Osteo-arthritis of the spine with its lipping is a process which accompanies degeneration of the intervertebral discs.

The author reports 38 cases of lesions of a cervical disk in the past year. Myelograms were made in only a small percentage of these, and operations were performed in only 4 cases. He discusses the importance of recognizing the brachial neuritis syndrome and of appreciating the part played by the intervertebral disk and emphasizes conservative treatment.

[ED. NOTE.—The implication is that almost all instances of brachial neuritis are due to protrusion of a disk. It must be remembered that there are other causes for brachial neuritis besides protrusion of a cervical disk. Even in cases with typical signs and symptoms of protrusion of a lumbar disk, one can really only make a diagnosis of lesion of a nerve root, probably due to protruding intervertebral disk. The many other possible causes of irritation of the nerve roots can be demonstrated only at operation or in other studies.]

General Conditions.—Young [1034] also reports a study of diseases of cervical and thoracic intervertebral disks. He states the opinion that "neck pain, . . . scapular pain and . . . cervico-brachial pain" are frequently due to disease of a cervical intervertebral disk, and that whereas cervical intervertebral disks are commonly the site of degenerative processes, herniation is rare.

. . . the opposing surfaces of the cervical vertebrae are more cup-shaped than those of the lumbar region and they tend to hold the cervical disk in place.

Identical signs may occur in degeneration of a cervical disk if one vertebra suddenly subluxates on the other. Both herniation of a cervical disk and subluxation of a cervical vertebra may respond to treatment by traction, so that the final diagnosis may be made only at operation.

1034. Young, J. H.: Cervical and Thoracic Intervertebral Disk Disease, M. J. Australia **2**:833-838 (Dec. 14) 1946.

Before I knew anything about cervical disk disease I used to carry out manipulation in cases like these, sometimes producing relief. Now that I know what the pathology is and what damage may be done by manipulation, I prefer traction with a Glisson's sling.

[ED. NOTE.—This note of caution from a man of extensive experience with the problem deserves consideration by those who sometimes overemphasize the use of manipulation.]

The author differentiates between herniation of a degenerated cervical disk and traumatic rupture of a disk followed with a later degenerative process. He states the opinion that the true incidence of disease of cervical disks is not yet known. The importance of differential diagnosis is emphasized and conservative treatment outlined. The radicular syndromes are discussed. A chart of the dermatomes and of variations in the segmental supply of the muscles and skin is included.

The author also reports a study of 66 patients with thoracic backache who presented no obvious evidence of visceral disease or of neurosis. He discusses the lesions in 13 cases of disease of thoracic intervertebral disks in which diagnosis was confirmed roentgenographically or at operation. Among the 4 cases in which surgical treatment was given, involvement of the third disk was noted in 1; of the tenth disk, in 2, and of the eleventh disk, in 1. In all 4 the results of the mobility test proved reliable. At the time of the report, the results were excellent. The conservative treatment of disease of a thoracic disk consists of relief of pain and avoidance of strain, with the use of a corset or brace.

[ED. NOTE.—This excellent article, by an author who has evidently had considerable experience with involvement of the disks should be read by any one interested in the problem.]

PYOGENIC INFECTION OF THE EPIDURAL SPACE

Rankin and Flothow[1035] report a case of pyogenic infection of the spinal epidural space. They state that they believe the case to be worthy of note because:

(1) There was gross radiographic evidence of osteomyelitis of the vertebrae, which is unusual in epidural granulomas; (2) the mass was situated in the cervical epidural space, where they infrequently occur; (3) the inflammatory process involved the nerve roots primarily, and there was no evidence of damage to the spinal cord itself; (4) despite inexcusable delay in carrying out the proper treatment, operation effected a complete functional recovery as well as an apparent cure of the vertebral osteomyelitis.

1035. Rankin, R. M., and Flothow, P. G.: Pyogenic Infection of the Spinal Epidural Space, West. J. Surg. **54**:320-323 (Aug.) 1946.

In reviewing the literature, the authors found that 217 case reports had been collected by Browder up to 1941 and that 8 cases had been reported from then to the time of the report. They stress the fact that the disease is unfamiliar to most physicians and is rarely diagnosed before the onset of irreparable damage to the spinal cord.

The disease is likely to occur in the wake of suppurative infection anywhere in the body. Since there are few physicians who are not frequently called upon to treat infectious processes it behooves us to be aware of this disease entity.

Pyogenic infection of the epidural space is not rare. It has been considered so because it is rarely recognized.

The disease occurs at any age, the youngest patient in the cases reported being an infant of 1 week and the oldest, a man of 67.

Males are affected three times more frequently than females.

Epidural space infection is always secondary to a suppurative process elsewhere in the body, although at times the primary site cannot be found. The bacteria invade the spinal canal either by direct extension from a contiguous suppuration (that is, osteomyelitis of vertebrae, sacral decubitus, or cellulitis of neck), or by metastasis via the blood or lymph channels. The latter route is exactly analogous to acute hematogenous osteomyelitis. . . . In the great majority of cases the causative organism is staphylococcus, but other organisms have been reported.

In the cervical region the [epidural] space is only a potential one but at the level of the fourth dorsal segment it broadens out and remains so down to the eighth dorsal segment where it becomes narrow, but it broadens out again between the third lumbar and the second sacral segments. It is in the broad areas that infections usually localize.

Infection in this space may be either extremely fulminating (epidural abscess) and cause death in a matter of hours, or it may be chronic (epidural granuloma) causing progressive paralysis over a period of months or years. Occasionally there occurs a subacute form made up of miliary abscesses in a fibrous granulomatous matrix. Regardless of the type of extradural infection, there is profound damage to the underlying spinal cord. Pathologically there is extensive myelomalacia with liquefaction and vacuolation of the white substance, swelling and chromatolysis of the neurocytes, and inflammatory reaction of the glial cells. The spinal cord degeneration is far out of proportion to pressure of the extradural mass itself. This is believed to be due to thrombosis of intraspinal vessels and obliteration of the intraspinal lymph spaces caused by the contiguous, but transdural, inflammatory process. There is virtually never invasion of the subarachnoid space with resultant leptomeningitis. The rare cases which have been reported have been due to: (1) osteomyelitis of the vertebral bodies bursting through the adherent dura anterior to the cord; or (2) insertion of a lumbar puncture needle through the infected area into the subarachnoid space. [ED. NOTE.—This is another situation where ill advised lumbar puncture may be a cause of considerable harm.]

The clinical course of events in epidural space infection follows a monotonously regular pattern. In the wake of any concurrent or preceding major or minor infection, the patient suddenly develops a severe intractable pain in the vertebral axis. A day or two later, or frequently within a few hours, he complains of radicular pains in the distribution of the involved segment. The vertebral and

root pains are exacerbated by coughing and sneezing. In one-half the cases there is tenderness to percussion and palpation of the involved spines, and localized swelling frequently occurs. There is marked rigidity of the spine and nuchal rigidity is present. A day or so later the inevitable symptoms of cord compression appear. There is difficulty in urination, leading to complete paralysis of the bladder. Concurrently paralysis and loss of sensation below the lesion occurs, resulting in complete paralysis and a sensory level. Beginning just prior to or at the time of the onset of the pain there is fever, which may reach high levels and is accompanied by leukocytosis, tachycardia, elevated sedimentation rate and circulatory collapse.

The spinal fluid shows quite characteristic changes. The protein is almost invariably elevated, usually 100 to 300 mg., occasionally reaching 4000 mg. There is usually, but not always, a moderate pleocytosis of 15 to 150 cells, mostly lymphocytes. Sugar and chlorides are within normal limits, but the colloidal gold curve is usually abnormal. Xanthochromia is frequent. The Queckenstedt test almost invariably demonstrates a partial or complete subarachnoid block, and on this the diagnosis is based.

In chronic and subacute epidural space infections the identical pattern and findings are present, except that the course is less fulminating and may extend over a period of months and years instead of hours or days. Also, there is little or no febrile reaction and the local vertebral signs and symptoms are less apparent.

If one is cognizant of the disease, the diagnosis may usually be inferred by the characteristic history and physical findings. Demonstration of a partial or complete subarachnoid block on the Queckenstedt test or myelography completes the diganosis, although the inflammatory nature of the extradural mass is frequently not proven until operation is performed. In the acute form the disease is often mistaken for the other causes of acute febrile illness with localized pain: that is, pyelitis, appendicitis, pneumonia, pleurisy, and so forth. In the chronic forms it is usually confused with primary chronic neurologic diseases: poliomyelitis, multiple sclerosis, transverse myelitis, and so forth. In all cases a carefully performed Queckenstedt test should lead one to the correct diagnosis. If the physical findings make one suspicious of an epidural inflammatory mass in the lower lumbar region, puncture of the lumbar spinal sac should not be done, as a fulminating leptomeningitis may result. In these cases cisternal puncture and myelography will confirm the diagnosis. Radiographic evidence of destruction of the vertebrae themselves is the exception rather than the rule.

Once the diagnosis has been established, laminectomy is imperative. In the acute cases immediate operation is as essential as it is in cases of ruptured spleen or acute appendicitis, as irreparable damage to the spinal cord and/or death may occur in a few hours after the onset of symptoms. The mortality without operation is 100 per cent, and less than one-half of the patients whose cases are recorded were operated upon soon enough to prevent untoward results. The chronic cases are handled as any spinal cord tumor. Systemic penicillin and/or sulfonamides should always be used in conjunction with operative treatment.

The prognosis is directly proportional to the rapidity with which the diagnosis is made and proper treatment carried out. The over-all operative mortality is thirty-three and one-third per cent, most operative deaths occurring in the acute forms. Of the patients surviving operation, 40 per cent have complete return of function.

[ED. NOTE.—This is an excellent paper, reviewing the problem of pyogenic infection of the epidural space. The author has done well to bring the condition to our attention, as the diagnosis is evidently rarely made soon enough to prevent permanent disability or death.]

POSTURE

Kuhns [1036] discusses normal posture in early childhood:

> Normal posture in infancy can be defined as the absence of noticeable deformity. There is no active resistance to gravity and the baby posture is molded by the contours of the furniture on which he lies. During the first year of life postural training is chiefly passive—keeping him in an environment which does not permit the long-time assumption of faulty attitudes. . . . Set exercises are rarely practicable before the school age. Posture teaching is chiefly by precept and by example. Other helpful measures such as adequate rest and proper nutrition must be kept constantly in mind.
>
> While much of the unsteadiness and lordosis of the low back and weakness at the knee and foot are temporary and show considerable spontaneous improvement with growth, good balance of the body over the center of gravity never comes without proper development and coordinated action of the muscles which control the pelvis and balance the trunk over it. For almost all children this requires special guidance and training. Only a few, less than 5 per cent, develop good posture spontaneously.

[ED. NOTE.—Opinions differ on the subject of posture. Some writers state the belief that normal, healthy children usually develop normal posture without any postural training if their parents have normal posture. If less than 5 per cent of children develop good posture spontaneously, it is interesting to think what the posture of the world population must be, since a relatively small percentage of the population has the opportunity for special guidance and training.]

Howorth,[1037] in an extremely interesting and complete study of posture, presents his ideas on what he calls dynamic posture. He states:

> Posture has long been thought of in terms of standing and sitting, and correct posture as the erect position assumed as one is under inspection, but posture should really be considered as the sum total of the positions and movements of the body throughout the day and throughout life. It should include not only the fundamental static positions in lying, sitting and standing and the variations of these positions but also the dynamic postures of the body in motion or in action, for it is here that posture becomes most important and most effective.

1036. Kuhns, J. G.: Normal Posture in Early Childhood, Pub. Health Nursing **38**:406-410 (Aug.) 1946.

1037. Howorth, B.: Dynamic Posture, J. A. M. A. **131**:1398-1404 (Aug. 24) 1946.

The author describes the development of posture, reviewing the baby's posture as well as that of the child and the adult. The many variations of lying posture and the effect of various types of support and positions, including the hammock and various types of bedsprings and mattresses, are discussed, as are the sitting posture and the effect of various seats and supports.

The author considers the standing position as "a basic position from which constant changes are made rather than as a position continuously held." The characteristics of ideal posture at rest and for the dynamic position of expected forward movement are presented. Individual types of posture, poor posture and its causes and effects, and posture correction are discussed.

Dynamic posture is posture in motion or in action or in preparation for action. Good dynamic posture implies the use of the body or its parts in its simplest and most effective way, using muscle contraction and relaxation, balance, coordination, rhythm and timing as well as gravity, inertia and momentum to optimum advantage.

Movement is the basis of dynamic posture. Good dynamic posture is common to such animals as the cat and the horse and often to children and primitive man but is uncommon in adult civilized man.

[ED. NOTE.—This interesting approach to the problem of posture should be read by any one interested in the study of posture.]

PARAPLEGIA

Poer [1038] discusses the newer concepts in the treatment of patients paralyzed owing to injuries of the spinal cord and outlines a plan of treatment, giving a statistical analysis of the cases studied. He points out that whereas approximately 2,500 soldiers and sailors received such injuries in World War II, the final mortality rate may show a large decrease, from an all-time high for the Balkan Wars of 95 per cent (the average for other wars was 50 to 60 per cent) to approximately 20 per cent in the last war. Lowering of the battlefield mortality produced an increase in the number of patients to be cared for. The author discusses ways and means by which these patients can be restored to some type of ambulation.

In his statistical analysis of 77 cases in which the patients were treated within a fifteen month period, there were 15 cases of cervical involvement; 18, of involvement of the cauda equina in the lumbar area, and 5, of such involvement in the sacral area. The remaining 39 patients were injured in the region of the dorsal spine. Twenty-nine of the patients had complete transection of the cord.

1038. Poer, D. H.: Newer Concepts in the Treatment of the Paralyzed Patients Due to War-Time Injuries of the Spinal Cord, Ann. Surg. **123**:510-515 (April) 1946.

Seventy-four per cent had serious emaciation, with an average loss of weight of 42.5 pounds (19.33 Kg.) per person. Forty-four patients had undergone primary laminectomy.

[Ed. Note.—This is an interesting and extensive study of one of the most difficult problems in orthopedics—the paraplegic patient. It is interesting to note the number of laminectomies which were done. Though it is stated that the orthopedist treats the fractures and supervises the mechanical means of walking, nothing is said about spinal fusion in this series.]

Botterell and his associates [1039] report a study of paraplegic patients. The authors describe and illustrate long leg braces of chrome molybdenum, especially suitable for paraplegic patients, and custom-made, modified hockey cut-type boots which are light in weight and particularly flexible; the boots are recommended for prevention of pressure sores on the feet. A simple "bed exerciser" is also described. Paraplegic patients should be evacuated as early as possible to a center fully equipped and specially staffed to deal with all aspects of treatment and retraining. The authors emphasize the importance of enthusiastic cooperation of the patient and of all those attending him, pointing out that almost any patient with an injury to the spinal cord can be salvaged to occupy a useful place in society.

[Ed. Note.—This, also, is an excellent study of the problem of the paraplegic patient. The authors discuss the treatment of the paraplegic casualty with a stable spinal column but do not go into the problem of the unstable spine and the indications for spinal fusion.]

Covalt [1040] discusses the rehabilitation, as planned by the Veterans Administration, of the patient with severe injury to the spinal cord. The author emphasizes five phases of treatment: neurologic, urologic, surgical, psychiatric and physical. He states that patients thus affected in the first World War usually died in a period of a month to a year and a half, and that only 1 such patient survived at the time of the report. With new drugs and improved surgical management, a modern medical rehabilitation program makes it possible for paraplegic patients to live as long as so-called normal people. At present there are 2,000 patients in this country with severe injuries to the spinal cord; the Veterans Administration has approximately 1,000 in its care. Paraplegic patients will be concentrated in five or six special centers of

1039. Botterell, E. H.; Jousse, A. T.; Aberhart, C., and Cluff, J. W.: Paraplegia Following War, Cincinnati J. Med. **27**:595-623 (Sept.) 1946.

1040. Covalt, D. A.: The Rehabilitation of the Veteran with Severe Spinal Cord Injury, Occup. Therapy **25**:187-190 (Oct.) 1946.

the Veterans Administration. Special teams composed of a neurosurgeon, a physical therapist, physical therapy technicians, occupational therapists, supervisors of corrective physical rehabilitation, nurses and others will treat these patients.

The program as developed in the Veterans Administration includes specific and detailed training for the paraplegic so he may accomplish the 72 activities necessary for the physical demands of daily life. They range from (1) moving from place to place in bed, to (72) driving a car. There are 37 activities for non-walkers; 17 for walkers; 12 having to do with getting up and down; 4 for endurance and speed so as to keep up with the demands of daily life; and 2 for traveling by car or other suitable vehicle.

[ED. NOTE.—The author discusses the program in some detail, stressing the importance of medical, social and vocational treatment, and emphasizes occupational therapy and rehabilitation.]

SCOLIOSIS

Mol and van der Zijl[1041] discuss the influence of the abdominal muscles in the production of scoliosis. Lowman's operation of fascial transplantation for reenforcement of the weak or paralyzed abdominal muscles and the modifications of Mayer and of Dickson are discussed, and the authors present a modification of their own. They state that a patient with scoliosis not preceded with poliomyelitis merits examination of the abdominal muscles as well as one with a history of poliomyelitis, and that "after a minute examination one will find that many idiopathic scolioses are caused by a paralysis of the abdominal muscles." One case with operation according to Lowman's method and 3 cases in which treatment was by the authors' modification of Lowman's procedure are reported. They state the belief that their method has three advantages:

First, the "natural" insertion of the muscular sheath of fascia lata at the iliac crest;

Second, the greater solidity of the transplanted material containing as well contractile elements . . . even if the tensor fasciae latae degenerates;

Third, the reenforcement of a part larger than the weakened part.

[ED. NOTE.—Further evidence is necessary to support the authors' claim that in many cases idiopathic scoliosis is caused by paralysis of the adbominal muscles. The authors imply, as many others have, that the indicated treatment of scoliosis due to paralysis of the abdominal muscles following poliomyelitis (or even the treatment of idiopathic scoliosis) is a modification of the Lowman fascial transplantation,

1041. Mol, W., and van der Zijl, M. O.: Scoliosis Due to Paralysis of Abdominal Muscles, Rev. d'orthop. **32**:151-159 (May-Aug.) 1946.

and many inexperienced orthopedic surgeons may be misled. Whereas fascial transplantation may aid weakened abdominal musculature following poliomyelitis in selected cases, it seems obvious that one cannot hold up a severely telescoping, unstable, segmented vertebral column, in any severe case of scoliosis following poliomyelitis, with fascial abdominal transplants. Spinal fusion is necessary in most severe cases if stabilization or prevention of further progress of the curve is to be expected. In many cases in which abdominal transplants seem indicated, it is found that the procedure is not necessary after adequate spinal infusion.]

Marique [1042] describes the use of a semibent plaster jacket in the treatment of scoliosis. He uses it especially in cases of a single curve, which he states constitute about 40 per cent of the total. He states the belief that his type of jacket is original, as he found no reference to the treatment in the literature.

[ED. NOTE.—The method has been used in this country for some years by a number of different orthopedic surgeons, although there is a variation in the way the jacket is applied. No one has as yet reported any extensive series of cases in which roentgenograms were made to prove the efficacy of this treatment. In my experience, a relatively small percentage of instances of idiopathic scoliosis are of the single curve type. Most patients with idiopathic scoliosis show more than one structural curve, and it is obvious that the application of a semibent jacket might be advantageous for one curve and not so good for the opposite one.]

XXI. RESEARCH

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THE LITERATURE on orthopedic research and related subjects for 1946 shows a preponderance of articles on changes in the bone associated with hormones. However, there are no outstanding articles among this group. Seventy-one articles were abstracted for this review, and thirty-one have been selected as references. They are divided into the following subjects: (1) changes in the bone, associated with hor-

1042. Marique, P.: Contribution au traitement de la scoliose, Rev. d'orthop. **33**:61-64 (Jan.-March) 1947.

mones and other substances; (2) biochemical studies; (3) anatomic and physiologic studies; (4) studies of muscle; (5) studies of cartilage, fascia and joint; (6) fluorine studies, and (7) miscellaneous research.

CHANGES IN THE BONE, ASSOCIATED WITH HORMONES AND OTHER SUBSTANCES

M. and R. Silberberg [1043] state:

In immature male mice, testosterone propionate accelerated the ageing of the epiphyseal cartilage by inhibiting proliferation and by increasing regressive changes. These effects were less marked in males than in immature females. Removal of the testicles caused a delay in the development of the cartilage, followed by a reduction in the rate of proliferation. . . . Administration of small doses of testosterone propionate to castrate mice restored both development and growth of the epiphyseal cartilage. The resumption of growth is incidental to the restitution of the development of the cartilage and is not due to a direct growth-stimulating effect of the hormone.

It has been shown that both estrogenic and thyrotropic hormones accelerate skeletal aging in growing animals, although their effect is exerted on different phases of the skeletal time curve. Thyroxin has little effect on growth but hastens the resorption of cartilage and bone, leading to epiphysial and diaphysial union. Estrogen, however, suppresses growth and inhibits the resorptive processes. In the reported experiment, M. and R. Silberberg [1044] dealt with the combined action of the two hormones in young mice. Under combined therapy, the age changes in growth zones at any given stage were considerably advanced over those in untreated animals. After two months' observation, it was noted:

. . . the addition of thyroxin did not materially affect the decrease in the proliferation of the cartilage caused by estrogen; . . . On the other hand, the metaphyseal connective tissue was less hyalinized, and the bone present was less abundant and more loosely knit than after injections of estrogen only.

After 6 months of observation . . . resorption of the epiphyseal cartilage resembled closely the same processes seen after administration of thyroxin alone . . . [although less advanced]. . . . Resorption of bone in the shaft and metaphysis was more conspicuous after administration of both hormones than after that of estrogen alone.

It is therefore clear that the two hormones tend to compete with each other "in enforcing their characteristic changes on the skeletal time curve."

1043. Silberberg, M., and Silberberg, R.: Further Investigations of Effect of Male Sex Hormone on Endochondral Ossification, Anat. Rec. **95**:97-117 (June) 1946.

1044. Silberberg, M., and Silberberg, R.: Skeletal Changes Caused by Combined Administration of Thyroxin and Estrogen, Am. J. Path. **22**:1033-1045 (Sept.) 1946.

Benoit, Messerschmitt and Grangaud [1045] state that a daily injection of 1 mg. of estradiol benzoate in immature drakes causes abundant formation of bone in the marrow cavities of various parts of the skeleton, especially in the femur and tibia. The marrow reduces in volume and becomes less fatty and more hematopoietic. In proportion to body weight, the injection of estradiol benzoate causes a considerable increase in weight of the femurs and tibias. The blood calcium and phosphorus are increased for a few days and then slowly return to normal, even though injections are continued.

Sammartino and Terzano [1046] found that the daily injection of 1 cc. of estrogen (estradiol benzoate) into the leg muscle of 3 month old leghorn chickens for twenty-two days (a total of 220,000 international biologic units) caused an increase in the blood calcium and an increase in the bony trabeculae in the medullary cavity of the long bones (epiphysis and internal surface of the diaphysis in femur and tibia), with incomplete and imperfect ossification and defective absorption of cartilage.

[ED. NOTE.—The accumulation of experimental evidence on the formation of bone in animals, especially in the medullary cavity after the administration of estrogen, may be of great importance in explaining some of the unknown factors in ossification. Such an explanation might lead to important data to be used in the treatment of fragile bones, cystic disease of bone, osteomalacia or osteosclerosis.]

After the administration of pituitary growth hormone to hypophysectomized rats, Becks and his co-workers [1047] noted that osteogenic processes in the epiphysial cartilage of the tibia were reawakened, even after postoperative intervals of a year or more:

> Some response was obtained within 5 days, but daily doses of 200 to 400 mg., given for 25 to 30 days, were necessary for reestablishment of vigorous osteogenesis comparable to that seen in the normal, young, growing rat.
>
> Thyroxin had a synergic effect on this response to growth hormone, provided only that the dose was low enough for it to be tolerated by these animals. Thyroxin alone stimulated some proliferation and enlargement of cartilage cells . . . but little osteogenesis.
>
> Contrary to the results seen in the epiphyseal cartilage of the tibia, thyroxin was found to antagonize the effect of growth hormone on the cartilage covering the

1045. Benoit, J.; Messerschmitt, J., and Grangaud, R.: Osteogenetic and Hypercalcemic Action of Estradiol Benzoate in Male Domestic Duck: Chemical Study, Compt. rend. Soc. de biol. **135**:1593-1596, 1941.

1046. Sammartino, R., and Terzano, G.: Bone Changes in Chickens Receiving Estrogens, Prensa. méd. argent. **33**:362-366 (Feb. 15) 1946.

1047. Becks, H., and Others: Response to Pituitiary Growth Hormone and Thyroxin of Tibias of Hypophysectomized Rats After Long Postoperative Intervals, Anat. Rec. **94**:631-655 (April) 1946.

head of the tibia. This antagonism had previously been observed in the condyle of the mandible in the same animals.

[ED. NOTE.—The study of hormones as related to orthopedics is still in its infancy, and no important clinical application is evident at present. The use of thyroxin, estrogens or androgens to promote early epiphysial union may be feasible in the future. Apparently contradictory results reported by various investigators may be explained on the basis of difference in dosage. Small and large doses of the same drug in some instances produce opposite effects.]

Votansky, in 1930, succeeded in producing typical signs and symptoms of osteitis fibrosa cystica in dogs by means of injection of parathyroid extract. The dogs were fed a well rounded diet, including occasional administration of calcium salt. However, Burns and Henderson [1048] were unable to duplicate these findings under similar conditions, although the dogs were given a calcium salt regularly. The authors state the opinion that calcium intake is the most important single factor in the experimental production of hyperparathyroidism. In their experiments, administration of parathyroid extract in association with a low calcium intake resulted in a decrease in serum calcium nearly to the level for tetany. With higher calcium intake, the decrease did not occur. In neither instance was there any measurable chemical effect on bone growth or on decalcification. Even with a low level of serum calcium, the calcium content of bone was not appreciably disturbed. In puppies, the amount of calcium laid down in bones and the level of serum calcium varied directly with the calcium intake. It is the authors' opinion that the parathyroid gland influences both the building up and the breaking down of bone, as suggested by other investigators, but the final equilibrium between bone calcium and blood calcium is determined by activity of bone cells and by calcium intake.

In experiments conducted on hypophysectomized rats, Reiss, Fernandes and Golla [1049] showed that large doses of testosterone propionate definitely inhibited the action of the growth hormone. In addition, increase of body weight was less when the androgen was given in conjunction with the growth hormone. Testosterone propionate itself, given in doses of 4 mg. daily, did not affect growth or influence the decrease in weight usually noted after hypophysectomy. A dose of 0.1 mg. of estrone produced similar results, and 2 mg. of desoxycorticosterone acetate, effects somewhat similar. The results of the investigations showed that large doses of testosterone propionate had an inhibitory

1048. Burns, C. M., and Henderson, N.: Mineral Constituents of Bone: Effect of Prolonged Parathormone Injections on Composition of Bones of Puppies with Varying Calcium Intakes, Biochem. J. **40**:501-507, 1946.

1049. Reiss, M.; Fernandes, J. E., and Golla, Y. M. L.: Peripheral Inhibitory Influence of Large Doses of Testosterone on Epiphysial Cartilaginous Growth, Endocrinology **38**:65-70 (Feb.) 1946.

effect on the cartilaginous activity of the growth hormone; this might be explained on the basis of increased circulation and increased calcification. Other workers have demonstrated an opposing or synergistic effect between administration of growth hormones and small daily doses (0.05 to 1.0 mg.) of testosterone.

In modern traumatology, insufficient attention has been given to new methods for stimulating regenerative osteoblastic reaction in the treatment of fractures. Positive results in such experiments have hitherto been lacking. Clinical observations indicate that even when all other conditions are the same, such as the type of fracture, the method of conservative treatment and the age of the patients, the time of consolidation of the fracture and the function of the growing callus often differ considerably. Thus a difference in the reactivity of the connective tissue cells involved in callus formation is clearly indicated. Bogomolets,[1050] in his work, has sought a method to stimulate regenerating osteoblastic action. He analyzes the effect of the antireticular cytotoxic serum on the consolidation of bones after fracture in experimental and clinical cases. It was suspected that the stimulating effect of antireticular cytotoxic serum, previously observed on some of the cellular elements of the connective tissue system, might also occur in the osteoblastic elements, and the suspicion was confirmed. In small stimulating doses, serum exerts an intensive and specific effect on acceleration of regeneration of osseous tissue. By use of the serum, the author has been able to obtain bone union in fractures considered hopeless. The effects of the serum on the cellular elements of the connective tissue system, such as the osteoblasts, vary with the dose administered. Large doses have an inhibiting effect on the cellular elements at the site of the fracture. Animals receiving large doses of the serum showed other pathologic conditions, such as low resistance to infection and, in some instances, progressive cachexia. Small doses also yielded good results in cases of retarded callus formation after fracture in both young and old persons. In older patients, there was pronounced improvement in general condition.

The histogenesis of the callus under stimulation with antireticular cytotoxic serum shows that there is active formation of osteoblasts, with accelerated transformation into osteocytes, which plays an important part in the acceleration of bone formation. For an average therapeutic dose, 0.07 cc. of undiluted serum, with a titer of 100 to 120, is recommended. The dose is injected subcutaneously at intervals of two to three days. The test with trypan blue is recommended for judging the stimulating effect of the serum.

1050. Bogomolets, O. A.: Effect of Antireticular Cytotoxic Serum on Histogenesis of Bone Callus, Med. zhur. **12**:283-291, 1944.

The use of the serum for the treatment of fractures requires careful observation of the process of repair by the attending physician, since the union may take place so rapidly that an accurate reposition of the fragments may not have been obtained.

In an attempt to corroborate the results of Bogomolets' work concerning the effect of antireticular cytotoxic serum on the healing of fractures, Straus and his co-workers[1051] carried out an experiment: Antireticular cytotoxic serum was prepared by injection of rabbit spleens and bone marrow antigen into goats. The radius and ulna of 156 rabbits were fractured experimentally with a Grattan osteoclast. The fractures were immediately reduced and immobilized. Three days after operation, the rabbits were arbitrarily divided into four groups: Group A received small stimulating doses of antireticular cytotoxic serum; group B received large doses of the same serum, and groups C and D were composed of control animals, which received small and large doses of goat serum.

The results were graded according to roentgenographic evidence of callus on the seventh, tenth and fourteenth days; gross postmortem evidence of bone and callus formation; microscopic examination of bone at the fracture site, and breaking point of bone at the fracture site, determined by subjecting the bone to a mechanical strain.

The animals in group A, which received small doses of antireticular cytotoxic serum, showed roentgenographic evidence of callus earlier than those in any other group; the callus was also greater in amount. Postmortem examination revealed similar changes. Microscopic examination showed a greater degree of new bone formation. The breaking point of the bones of these animals was the highest in all groups, the average force required being 7,000 Gm. Animals in group B, which received large doses of antireticular cytotoxic serum, showed least evidence of new bone formation on roentgenographic and microscopic examination, and the lowest breaking point (680 Gm.). Ratings of control groups C and D were intermediate between those of groups A and B, with an average breaking point of 3,365 Gm.

The authors state the opinion that the results did corroborate the work of Bogomolets.

[ED. NOTE.—The results of the work of Bogomolets and their corroboration by Straus and his co-workers may be of definite clinical significance in the treatment of slowly healing and ununited fractures. The procedure needs a great deal more study before it can be used routinely if the statement of Bogomolets, that the process of repair may be so greatly accelerated that an accurate reposition of fragments may not have been obtained before union is complete, is correct.]

1051. Straus, R., and Others: Studies on Antireticular Cytotoxic Serum: III. Effect of ACS on Healing of Experimentally Produced Fractures in Rabbits. J. Immunol. **54**:163-177 (Oct.) 1946.

BIOCHEMICAL STUDIES

Tarantino [1052] showed that immobilization of the hindlimbs of rabbits in plaster casts produces a significant increase in blood calcium, and a significant reduction in phosphorus, potassium and magnesium. These changes subside in fifteen to thirty days after removal of the cast, to reach normal levels. The author attributes the changes to functional inactivity.

In a preliminary discussion of their investigations, Baker, Butterworth and Langley [1053] emphasize the constancy of calcium in bone per unit weight. In pathologic conditions, such as rickets or osteomalacia, produced either by a vitamin D deficiency or by a lack of calcium phosphate, there is interference with the calcifying process so that osteoid tissue fails to calcify normally. In no other known disease, however, is there histologic evidence of calcium deficiency in bone substance. The term "decalcification," rather loosely used to describe such conditions as osteoporosis, describes a process which is in reality and histologically a deossification. Protein matrix and calcium are removed together. The bone which remains is normally calcified. In fibrosis of bone, as fibrous dysplasia, bone is actually replaced by fibrous tissue.

In the investigations, bone was taken from the cortex of the adult femur, the cancellous portion of the adult femur, the adult rib, the infant rib and, in 6 cadavers, from sequestrums. The bone was thoroughly cleaned, defatted and dried, after which estimates of calcium and nitrogen were made. No significant differences were found in the content of calcium and nitrogen in the cortical or cancellous bone of the femur or in the sequestrums. The infant rib contained more nitrogen and less calcium than the adult rib, a condition which might have been expected. The authors could not explain the significantly high nitrogen content in the adult rib as compared with that in the adult femur. The ratio of calcium salt to protein averaged 2.5 for sequestrums, 2.4 for cortical bone, 2.3 for cancellous bone of the femur, 2.1 for adult rib and 1.9 for infant rib.

[ED. NOTE.—The study of the nitrogen content and the other organic portions of bone represented by the protein matrix is an almost untouched field of research. It is to be hoped that in the future more research workers may direct their attention to this portion of the bone, which constitutes approximately one third of the bone by weight and two thirds by volume.]

1052. Tarantino, A. M.: Contributions to the Study of Various Chemicals of Muscle During Mechanical Immobilization and the Subsequent Functional Reactivation: Variations of Calcium, Phosphorus, Potassium and Magnesium, Med. sper., Arch. ital. **10**:257-269 (Aug.) 1942.

1053. Baker, S. L.; Butterworth, E. C., and Langley, F. A.: Calcium and Nitrogen Content of Human Bone Tissue Cleaned by Micro-Dissection, Biochem. J. **40**: 391-396, 1946.

Feeding experiments were carried out by Nordfeldt [1054] on pigs, the diet of which consisted of grain, such as barley, oats and corn, and 2.5 Kg. of skimmed milk daily. In some cases calcium, phosphorus or activated 7-dehydrocholesterol (vitamin D_3) was added to the diet. The experiments took place over a three months' period, during which time the weight of the animals rose from 35 Kg. to 100 Kg. When calcium or phosphorus or both were added to the diet, a decrease in the fat content of the femur was noted. Activated 7-dehydrocholesterol, however, appeared to increase the fat content of the same bone. When calcium or phosphorus was given simultaneously with the activated 7-dehydrocholesterol, the increase in fat content was less. It thus appears that calcium or phosphorus, on the one hand, and activated 7-dehydrocholesterol, on the other hand, counteract each other in influencing the fat content of the skeleton.

Holmes and his co-workers [1055] assayed twenty-four samples of goat's milk and found that the values were: calcium, 137 mg. per hundred grams; magnesium, 17 mg.; potassium, 170 mg.; phosphorus, 112 mg.; fat, 4.4 per cent, and protein, 3.4 per cent. Goat's milk contains two to three times as much protein and over three times as much ash as does human milk, but there is present only two-thirds the amount of lactose in human milk and essentially the same amount of fat, iron and copper. The studies show that goat's milk has a mineral content much higher than that reported for human milk, and somewhat higher than that reported for cow's milk. However, the extent to which infants can utilize the additional minerals supplied by goat's milk is as yet an unanswered question.

[ED. NOTE.—The administration of raw goat's milk might be worth while in cases of evident deficient mineral content of bone, and it might be helpful in cases of ununited fracture in which the blood calcium is low.]

Brandenberger and Schinz [1056] performed a systematic investigation of calcification in the human body and studied the relationship between inorganic bone substance and various diseases of bone. The results were based primarily on roentgenologic study of the finer structure of calcification. The first part of the monograph is devoted to a review of the fine atomic structure of the involved combinations of calcium and is

1054. Nordfeldt, S.: Influence of Phosphorus, Calcium and Vitamin D_3 upon Fat Content of Skeleton in Growing Pigs, J. Nutrition **31**:565-572 (May) 1946.

1055. Holmes, A. D.; Kuzmeski, J. W.; Lindquist, H. G., and Rodman, H. B.: Goat's Milk as a Source of Bone-Building Minerals for Infant Feeding, Am. J. Dis. Child. **71**:647-653 (June) 1946.

1056. Brandenberger, E., and Schinz, H. R.: Nature of Calcifications in Man and Animals and Behavior of Inorganic Bone Substance in the Case of Chief Human Bone Diseases, Helvet. med. acta (supp. 16) **12**:1-63, 1945.

followed with a review of roentgenologic findings in 80 human skeletons, normal and diseased, and in thirty different animal species.

The authors review the present status of roentgenologic study of the inorganic components of normal bones and teeth and finally present a summary of the nature and condition of the crystals encountered. They were struck by the fact that all the varied types of calcification in normal and diseased bone showed uniform crystals. In attempting to determine the chief types of crystals in different calcification processes, they found that in all pictures there was one and the same type, possibly due to the fact that the organism, in precipitating calcium salts in most varied conditions and locations, tends to one type of medium, with a resulting uniform type of crystal. In man and vertebrate animals, the apatite form of crystal hydroxyl (apatite) predominates. Apatite structure is absent from all nonvertebrates in which the predominant form of crystal is calcite. In vertebrates, calcite crystal is found only in pancreatic stones and in the calcium portion of gallstones. Physiologically, calcite is found in man only in otoliths. No exception to the rule was observed in the various bone diseases, such as rickets, renal rickets or various types of osteomalacia. Apatite crystals were found in the teeth of vertebrates.

Roche and Mourgue [1057] showed in experiments that the excess of phosphorus in embryologic bone specimens before the appearance of points of calcification is composed almost exclusively of the radicals PO_4, which are easily ionizable and doubtless fixed to the protein matrix. The bone salts in the same organs contain a mixture of bicalcic phosphates and tricalcic phosphates, whereas in well calcified embryonic specimens one finds only tricalcic phosphorus. In skeletal tissue taken from sheep embryos before the beginning of calcification, orthophosphoric acid (H_3PO_4) is present, in feebly ionized form and probably bound to the protein matrix. The first bone salt is a mixture of dibasic calcium phosphate ($CaHPO_4$) and tribasic calcium phosphate ($Ca_3\ [PO_4]_2$); later only tribasic calcium phosphate is found.

Ankyloses of joints should not be considered merely as local lesions. In reality, ankylosis reflects a profound upset in the life of the bone. Cretin and his co-workers [1058] visualize circulation across the epiphysial line, whereby nourishment and waste products are continually interchanged between epiphysis and diaphysis. The authors state the belief that when the filter becomes obstructed, waste products, such as fat particles and oil, accumulate and interfere with the function of the joint.

1057. Roche, J., and Mourgue, M.: First Stages of Ossification and Formation of Bone Salt, Compt. rend. Soc. de biol. **137**:451-452, 1943.

1058. Cretin and Others: Contributions to the Histochemical and Therapeutic Study of Certain Types of Ankyloses, Bull. Acad. de méd., Paris **130**:257-258 (March 26-April 9) 1946.

Therefore, by surgical intervention, such as drilling, a communication may be reestablished between the epiphysis and the marrow cavity of the diaphysis. Several cases are reported in which good results were obtained by this method of treatment, in ankylosis of the knee joint following fracture and in ankylosis of the hip, associated with rheumatoid arthritis; relief from pain was obtained by this operative procedure, which is not discussed in any detail. Apparently, direct communication is established between joint and marrow cavities.

[Ed. Note.—It is difficult to imagine how the establishment of a communication between a joint and a marrow cavity or between an epiphysis and a diaphysis can affect ankylosis following fracture or associated with arthritis or, especially, affect pain, if present. The problem needs further study.]

ANATOMIC AND PHYSIOLOGIC STUDIES

Davies [1059] has made a thorough study of the anatomy and physiology of diarthrodial joints, with the following conclusions: The tissue composing diarthrodial joints arises from mesodermal elements; the joint cavity develops by liquefaction of mesenchymal tissue. The joint capsule, the periosteum and the perichondrium are composed of tough, inelastic, white fibrous tissue, which has good resistance to infection but poor powers of repair. The synovial membrane is soft, elastic and movable, with good nerve and blood supply and good phagocytic power.

Articular cartilage is smooth, elastic, devoid of sensation and avascular. It has no demonstrable blood or nerve supply. Between the articular cartilage and bone there is a zone of calcified cartilage. The cartilage cells toward the periphery are flat and small and continually removed by constant wear; thus, the cell content of cartilage decreases with age, and the amount of matrix increases proportionately. The metabolic requirements of cartilage are low. Lesions of the articular cartilage over weight-bearing surfaces have little tendency to repair. At the articular margins, repair may be aided by synovial ingrowth. Apposition of articular surfaces is essential to normal function of articular cartilage. Loss of apposition, as in congenital dislocation, leads to degeneration of the cartilage and formation of fibrous tissue.

Synovial membrane is defined as modified connective tissue. It covers all joints except the cartilage in weight-bearing areas. The underlying connective tissue is important in its quality and quantity and determines the mobility of the synovial membrane. The membrane is supplied with elastic tissue fibers, which are not present in the villi.

1059. Davies, D. V.: Anatomy and Physiology of Diarthrodial Joints, Ann. Rheumat. Dis. **5**:29-35 (Dec.) 1945.

After synovectomy, the lining is reformed by metaplasia of connective tissue, but the new lining probably does not preserve the special characteristics of synovia and the fluid is probably considerably modified.

The blood supply is quite rich, is situated superficially and arises from anastomotic branches of the main arteries nearby. Communications exist between the blood vessels and those of the adjacent epiphysis. Simple bruising over a joint is frequently associated with hemorrhage into the synovial cavity. A single lymphatic plexus lies in the synovial membrane, but lymph vessels are not so numerous as the blood vessels. No direct communication exists between the cavity of the joint and the lumen of the lymphatics.

According to Hilton, the same trunks of nerves whose branches supply the group of muscles moving a joint also supply nerves to the interior of the joint, and to the skin over the insertion of the muscles. The nerve supply of joints accompanies the arteries.

Solutions of particles of small molecular dimensions pass rapidly in either direction across the synovial barrier, mainly through a blood capillary bed. The lymphatic system plays a minor role in the process. The synovial fluid differs in physiologic, chemical and cytologic character from joint to joint. Albumin and globulin occur in the fluid in a 4:1 ratio, showing a much lower concentration than that in the serum. There is no fibrinogen in the joint fluid; consequently, it does not clot. Mucin can be precipitated, however. It is thought to be a secretion of synovial cells. Urea and amino acids appear in essentially the same proportion as in the blood. There is less glucose, however, and the level falls with an increased cell count in the synovial fluid. The levels for chloride and carbon dioxide are high, that for inorganic phosphate is approximately the same and those for sodium, potassium and magnesium are lower in comparison with blood levels. The level for calcium is high as compared with the blood; in conditions causing increased capillary permeability, the calcium content of the synovial fluid is further increased.

Red cells do not occur normally in the joint fluid. Monocytes and plasmacytes predominate, though lymphocytes are present in small numbers. The average cell count is 63 per cubic centimeter; degenerative changes cause an increase in the cell count.

[Ed. Note.—The article, although contributing no essentially new information, does contain an excellent summary of the anatomy and physiology of diarthrodial joints.]

In a report of a study of the blood supply and lymphatic drainage of tendons, Edwards [1060] states:

Almost the whole of the tendon is made up of collagen fibrils closely packed together, and apparently undergoing little or no metabolic activity. The living

1060. Edwards, D. A. W.: Blood Supply and Lymphatic Drainage of Tendons, J. Anat. **80**:147-152 (July) 1946.

part of the tendon consists of the tendon cells lying between the bundles of collagen fibrils they have produced, and the interfascicular connective tissue. It is these living tendon cells which require a blood supply.

[Each] tendon and its synovial sheath have one artery in the center, on each side thereof a vein, and the lymphatic vessels disposed as four main channels one on each side of each vein.

There are no valves . . . in the veins or lymphatics on the visceral synovial membrane, though they occur in the mesotendons.

There is a rich anastomosis in the lymphatic and venous systems. It is known that tendon is resistant to infection, can be transplanted and heals well as a result of excellent longitudinal anastomsis of blood vessels and frequent feeding by the synovia. Suture of a tendon within a synovial sheath is usually followed with adhesions. The author suggests that inversion of the edges of the sheath, as is done with peritoneum, may lower the incidence of adhesions after suturing.

[ED. NOTE.—This is a worth while and practical anatomic study.]

In a series of three articles, Mac Conaill[1061] presents a well written, highly complicated mathematical discussion of the mechanics of joint motions. Geometric factors are considered which determine the effect on a bone of successive movements at a joint. Such terms as cardinal movements, circumductions, conjunct and adjunct rotation and diadochal movements are defined and used to explain joint motion. Illustrations are given in experiments on the shoulder joint. In the two latter articles, an even more detailed study is made of the mechanics of saddle joints and hinge joints. The results of the experiments are presented, with numerous diagrams and mathematical formulas.

The variations of the tendo achillis were studied in a group of 100 autopsies by Cummins and his co-workers.[1062] Observations of the plantaris muscle were made in 50 specimens. Rotation of the fibers of the gastrocnemius muscle to the lateral side of the tendon, as first described by White, was confirmed in every case, although the rotation was of varying degree. Because of this peculiarity of the tendon a method of subcutaneously cutting the tendon is suggested which permits all the tendon fibers originating from both the gastrocnemius and soleus muscles to be cut without complete division of the tendon. A proximal section of the posterior two thirds of the tendon (the gastrocnemius portion) is

1061. Mac Conaill, M. A.: Studies in Mechanics of Synovial Joint: Fundamental Principles and Diadochal Movement, Irish J. M. Sc., June 1946, pp. 190-199; Studies in Mechanics of Synovial Joints: Displacements on Articular Surfaces and Significance of Saddle Joints, ibid., July 1946, pp. 223-235; Mechanics of Synovial Joints: Hinge Joints and Nature of Intra-Articular Displacements, ibid., Sept. 1946, pp. 620-626.

1062. Cummins, E. J., and Others: Structure of Calcaneal Tendon (of Achilles) in Relation to Orthopaedic Surgery, with Additional Observations on Plantaris Muscle, Surg., Gynec. & Obst. **83**:107-116 (July) 1946.

first made. A distal section is then made, in which the medial two thirds (the soleus portion) is divided. The plantaris tendon is also sectioned. In this way, all the fibers are severed either proximally or distally, except in those cases in which there is virtually no rotation of the tendon. In such cases, the few remaining lateral fibers of the soleus are easily torn.

A series of male mice were subjected by Lanier [1063] to daily, moderate, forced exercises from the age of 6 weeks for an average of twelve and a half months. A second series of mice, used as controls, were deprived of as much exercise as possible. The animals were killed at the end of the experiment:

> The controls were found to have more minor lesions in the articular cartilage than the workers. There was no difference in the incidence of the more severe lesions or of ossification of the patellar ligament. It is concluded that exercise is not an important factor in occurrence of articular degeneration in mice, and that muscular activity does not affect the formation of a bony crest at the attachment of the patellar ligament.

[ED. NOTE.—Perhaps human cartilage, also, would be better preserved with more joint exercise than the average person takes; the joints might remain more normal to a later period in life.]

STUDIES OF MUSCLE

In a study on the effect of electrical stimulation on atrophy and recovery of the gastrocnemius, Kosman, Osborne and Ivy [1064] prepared rats by crushing the sciatic nerves bilaterally at the sciatic notch. One group of rats had muscular tension in each leg measured regularly by an isometric myograph. They were killed at fourteen, twenty-one, twenty-eight, thirty-five and forty-two days and the weight of the muscles in the legs determined. Another group had one leg stimulated with a current producing forty contractions per minute for five minutes, twice a day; they were similarly killed. Comparisons were made also of weight and tension between the stimulated and the unstimulated leg and between the legs of treated rats and those of the controls. Tension was more sensitive than weight as an index of muscular repair. Stimulated muscles were heavier and stronger during both denervation and recovery. The experiment does not prove conclusively that earlier functional recovery is caused by stimulation; however, it is assumed that the muscle returns earlier to normal use when atrophy is prevented. When stimulation is delayed until a muscle fiber is reenervated, it is of no

1063. Lanier, R. R.: Effects of Exercise on Knee Joints of Inbred Mice, Anat. Rec. **94**:311-321 (March) 1946.

1064. Kosman, A. J.; Osborne, S. L., and Ivy, A. C.: Effect of Electric Stimulation Upon Course of Atrophy and Recovery of Gastrocnemius of Rat, Am. J. Physiol. **145**:447-451 (Feb.) 1946.

value; nevertheless, stimulation should not be discontinued at the first sign of neurotization.

[ED. NOTE.—This evidence is certainly in favor of early daily electrical stimulation of muscles paralyzed due to injury to peripheral nerves; it confirms the results obtained by Hines, Melville and Wehrmacher (*Am. J. Physiol.* **144:** 278-283 [July] 1945).]

STUDIES OF CARTILAGE, FASCIA AND JOINT

The object of a study by Jones [1065] and others was to determine the usefulness of curare in the differentiation of organic and functional factors in the limitation of passive motion at joints. Seventeen patients showing limitation of passive motion of joints were given curare intravenously in the form of purified chondodendron tomentosum extract (intocostrin®) after the usual subcutaneous doses of morphine and atropine. The intocostrin® was injected into the antecubital veins in such amounts as to render the patient unable to lift his head from the table. In each instance, the procedure produced weakness of the hand grip and of the thigh muscles. Initial doses varied from 20 to 50 mg. Additional curare was injected at intervals of two to four minutes, to produce the desired effect. Eight patients showed increased range of motion while under the effect of curare, while 9 showed no significant change. In 5 of 7 cases of fracture in which patients showed increase in range of motion after administration of curare, the improvement was retained in full or in part, which suggests the possibility of using this drug as an adjunct to treatment in some cases. Curare can relieve pain by causing relaxation of muscle spasm.

[ED. NOTE.—These observations add to our already extensive knowledge of the use of curare. The drug will undoubtedly, at some time in the future, have an established place in the treatment of many orthopedic conditions.]

A series of 6 dogs were subjected by Hudack [1066] to an operation in which the head of the humerus was resected and replaced with a metallic head of a chrome-nickel steel alloy. One of the 6 dogs was allowed to live more than five years after operation. Weight bearing on the operated leg started at one month; at three months the animal had full and apparently normal activity, although there was approximately 10 per cent limitation of motion in the affected limb. In five years, there was 20 to 50 per cent limitation of rotation but no roentgenographic evidence of arthritis.

1065. Jones, C. W.; Le Compte, C. B., and Kabat, H.: Studies on Neuromuscular Dysfunction, VIII: Use of Curare to Differentiate Muscle Spasm from Organic Changes in Limitation of Passive Motion of Joints, South. M. J. **39:**799-804 (Oct.) 1946.

1066. Hudack, S. S.: Study in Articular Replacement, Ann. Surg. **124:**277-287 (Aug.) 1946.

At postmortem examination there were noted some thickening of the joint capsule and slight hypertrophy of the glenoid cartilage. The replacement element was firmly fixed in place and was not eroded or rusted; on removal, the underlying part of the humeral shaft was covered with a smooth, fibrous membrane, under which was smooth, homogeneous, noncancellous bone. In non–weight-bearing areas there was dense, stratified connective tissue, lying on flat bone trabeculae. In areas of weight bearing with stress due to compression the adaptive tissue was found to consist of fibrocartilage, whereas in the region of less stress, the fibrocartilage and fibrous elements combined. Foreign body reaction was absent. Further investigation into adaptive function is suggested.

[ED. NOTE.—This is a most important study of the use of foreign material in reconstructive bone surgery. It partially answers such questions as: What happens to the end of the bone, the surrounding fibrous tissue and the remaining cartilage in the joint?]

Prior to the study by Chandy,[1067] the work of a number of investigators (principally Nageotte) had led to the belief that dead tissue, such as a fascial graft, is incorporated into living tissue without foreign body reaction by a process of revivescence. It was thought impossible to distinguish the graft from the surrounding tissue after a certain lapse of time, during which fibroblastic activity and formation of new blood were constantly going on.

The author, in a series of experiments, transplanted alcohol-preserved ox fascia in human beings and examined the tissue microscopically at varying periods from one week to four years after operation. Though the graft became rapidly attached to the human tissue, it was gradually replaced, over a period of time, by ingrowth of capillaries and fibroblasts and by human connective tissue. The process, however, was still incomplete after four years. The fascial graft was found to provide a lattice or framework, on which normal human tissue might grow. The findings of the author are somewhat at variance with the theory of Nageotte, who conceived of the graft as uniting or healing with living tissue.

[ED. NOTE.—The study shows that transplanted fascia provides only a framework on which normal tissue grows, which is similar to the role of transplanted bone.]

FLUORINE STUDIES

A condition in rats characterized by protrusion and mottling of incisor teeth has been diagnosed by Pande,[1068] from histologic examination of teeth and bones, as fluorine intoxication. The condition

1067. Chandy, J.: Fate of Preserved Heterogeneous Grafts of Fascia When Transplanted into Living Human Tissues, Surg., Gynec. & Obst. **83**:145-149 (Aug.) 1946.

1068. Pande, P. G.: Dental and Osseous Changes in Spontaneous Fluorosis in Rats, Indian J. M. Research **33**:121-128 (May) 1945.

occurred spontaneously in a colony of rats maintained on a diet which presumably contained a toxic dose of fluorine. The fluorine concentration in the bones of some of the rats was much higher than in those of animals kept on a low fluorine ration. Histologic changes in bones, such as osteoporosis, and in teeth in the spontaneous cases correspond closely in experimentally induced cases.

Fluorine is known to affect the tooth buds, but not adult teeth. The teeth of animals fed fluorine when young show mottled enamel when they erupt. Mostyn [1069] conducted experiments on pregnant dogs, which were fed on a diet containing large amounts of fluorine. Roentgenographic examination showed massive periosteal bone formation on the old cortex, especially in the long bones. In the case of puppies from a mother who has been on a fluorine diet, there were a blurred outline of the cortex of the bone and evidence of osteoporosis. The marrow cavity of the bones of the mother showed narrowing due to osteosclerosis. Cortical bone surfaces were rough, uneven and chalky, and extremely hard, though the bones of the offsprings were quite soft. Eruption of the permanent teeth was delayed. Experimental fluorosis could not be prevented or alleviated with an antirachitic diet.

MISCELLANEOUS RESEARCH

Zubiaurre [1070] demonstrated that the most significant roentgenologic features in alkaptonuric arthrosis are a productive, hypertrophic osteoarticular lesion, limited localization of the arthrosis in the hips, shoulders and spine, predominant involvement of the vertebral disk, showing calcification, and disappearance and changes in the vertebral bodies, showing deformation, decalcification or condensation and large production of osteophytes.

Experiments were performed by Lattes and Frantz [1071] on dogs to determine the effect of oxidized cellulose, fibrin foam and absorbable gelatin (gelfoam®) sponges on the healing of fractures. Oxidized cellulose in the vicinity of the fracture definitely interfered with normal bone repair. The mechanism of the interference was not definitely understood, but the presence of basophils in the tissue after introduction of oxidized cellulose suggested that a lowering of the local p_H might have been responsible by preventing the precipitation of inorganic calcium salt.

1069. Mostyn, H. J.: Fluorides: Chronic Fluorine Intoxication; Effect on Bones and Teeth, Vet. Med. **41**:408-409 (Nov.) 1946.

1070. Zubiaurre, L.: Radiologic Aspects of Alkaptonuric Arthrosis, Prensa méd. argent. **33**:1383-1387 (July 5) 1946.

1071. Lattes, R., and Frantz, V. K.: Absorbable Gauze in Bone Surgery: Experimental Studies Suggesting Clinical Application in Reconstruction of Joints, Ann. Surg. **124**:28-39 (July) 1946.

In clean bone surgery when rapid formation of callus is desired, fibrin foam or gelfoam® sponges are to be preferred to oxidized cellulose. It is thought that the former substances interfere with bone formation to a lesser extent. The use of oxidized cellulose in arthroplasty or other procedures, in which bone repair is not desired, is suggested.

[ED. NOTE.—Oxidized cellulose should have a place in reconstructive bone surgery, when minimal new bone formation is desired. Fibrin foam or gelfoam® sponges should be useful in the control of bone bleeding, especially in surgery of the spine.]

XXII. FRACTURE DEFORMITIES *

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WAR AND civilian casualties have in the past few years afforded an unprecedented number of serious, complicated injuries and diseases of the myoneuroskeletal system. During the same period of time, many new and radically different methods and medicaments have been advanced in the treatment of these conditions.

Reports on the use of, and results obtained with, these new methods and materials have been numerous, widely distributed and not without variance. The collective experience and results obtained yet await critical evaluation. Many basic or fundamental principles are manifest when the reports of the various authors are analyzed.

EARLY TREATMENT

In early treatment, says Renou,[1072] débridement with adequate excision of damaged soft tissue, minimal removal of comminuted bone, production of efficient drainage and complete immobilization of the affected parts are most essential. Tension in the closure of the soft tissues often means loss of life or of limbs.

Blood transfusions to combat shock and the use of penicillin combined with sulfonamide drugs permitted early secondary suture, or what might perhaps better be designated delayed primary suture, of wounds. The routine greatly lessened the number of severe infections and shortened the time required for healing, so that many men were returned to active duty who otherwise would have required long hospitalization.

* The first part of this review, by Leonard T. Peterson, M.D., and C. Glenn Barber, M.D., appeared in the ARCHIVES OF SURGERY for December 1948 (**57**: 855-870).

1072. Renou, C. A. M.: Early Treatment of Battle Casualties of Soft Tissues and Bone, Australian & New Zealand J. Surg. **15**:193-205 (Jan.) 1946.

The author describes in detail the manner in which the several medicaments and procedures were introduced.

PENICILLIN THERAPY

Abbott and his co-workers[1073] report 8 cases in which free bone grafts were implanted in infected bone defects in conjunction with penicillin therapy. The authors state the opinion that it is probably more desirable, in most instances, to attempt to obtain healing with penicillin therapy preliminary to the grafting procedure. The report includes data on the site from which the donor graft was obtained, the method of fixation of the graft, the types of organisms present in the infected area, the dose of penicillin, the duration of penicillin therapy and a summary of each case. It is concluded that adequate dosage with penicillin is a useful adjunct in all cases in which bone grafting and other operations are done in areas in which there are bone defects infected with penicillin-susceptible organisms.

In an attempt to evaluate bone grafting operations performed without the use of penicillin and operations in which penicillin therapy had been used, Branch and Moldavsky[1074] present reports of 93 cases in which bone grafting operations were deemed advisable to facilitate union. Fifty operations were performed before penicillin was available for use, and 43 were performed when it was used. The 93 patients represented about 3 per cent of 3,000 patients with war fractures treated in the same United States Army general hospital. The cases in which operation was performed are presented in separate groupings, according to simple or compound fractures and treatment (with or without the use of penicillin). The cases in which penicillin therapy was commenced immediately after the operation and those in which it was commenced two days prior to the operation are listed separately. Postoperative infection developed in 8 cases. There were 4 postoperative infections (8 per cent) in the 50 cases in which no penicillin therapy was used; the end results in the group were: 48 cases, good; 1, fair, and 1, failure. In the 43 cases in which patients received penicillin, there were 4 instances of postoperative infection, or 9.3 per cent; the end results were: 42 cases, good, and 1, failure. The authors state the belief that infection was less disturbing and that healing of wounds was best in those cases in which penicillin therapy was begun two days preoperatively.

1073. Abbott, L. C., and others: Use of Penicillin Therapy in Conjunction with Free Bone Grafting in Infected Areas, Surg., Gynec. & Obst. **83**:101-106 (July) 1946.

1074. Branch, H. E., and Moldavsky, L. F.: Penicillin and Bone Grafting Operations: Evaluation of Operations Performed Without Penicillin and Those Performed With Penicillin, Mil. Surgeon **99**:25-31 (July) 1946.

[ED. NOTE.—The material presented and the conclusions drawn in this report are worthy of detailed study and careful evaluation.]

Delayed osteosynthesis in conjunction with the administration of penicillin in 12 cases of irreducible open fracture is reported by Arnulf and others.[1075] Discussion is limited to but 10 cases, in which fifty or more days had elapsed after the patient received the war wound. Detailed reports of 6 cases are presented. In 5 of these, the fractures were due to projectiles; 1 was the result of a motor accident. The osteosynthesis was performed ten to twenty days after the wounding; all the wounds had received therapy with sulfonamide drugs until that time. In 2 cases bronze wire was used and in 5, a metal plate, with screws. When possible the incision was through normal skin, but in several cases it had to be made through the wound. Penicillin was administered in doses of 600,000 to 700,000 units by the intramuscular route, by perfusion and by injection *in situ*. Results were excellent, with little or no postoperative reaction.

INFECTED BONE DEFECTS

Despite the opinion of other authors that bone grafting in the presence of infection usually is unsound, during a period of fourteen months Coleman and others [1076] operated on 52 patients having large bone defects in which infection was present, with only 4 failures. Two of the successes were in cases of abscess of bone due to blood-borne osteomyelitis, which had occurred during childhood. Penicillin therapy was commenced two days before operation and continued after operation from two to five days after the temperature remained normal. Twelve different organisms were obtained from the sites of bone defects, but the same procedure was instituted regardless of their known susceptibility or resistance to penicillin or to the sulfonamide drugs. Cancellous bone chips obtained from the ilium were mixed with penicillin and sulfathiazole and packed into the bone defects after complete excision of all infected scar tissue or granulation tissue, dead bone and previously inserted foreign bodies. In 30 instances, excessive scarring and sinus formation necessitated some sort of plastic closure of the wounds. Closure without drainage or undue tension and the elimination of all dead space, using a full thickness skin graft if necessary to cover the skin defects, were considered essential. Immobilization in a plaster cast, which was not changed for at least three weeks, aided in the healing of soft tissues, and was con-

1075. Arnulf, G.; Ferrand, and Boquet: De l'emploi da la pénicilline dans les ostéosynthèses pour fracture ouverte des membres, Réunions méd.-chir. 1ere armée franç., pp. 123-129 (Nov. 4) 1944; ibid. (Feb. 25) 1945.

1076. Coleman, H. M.; Bateman, J. E.; Dale, G. M., and Starr, D. E.: Cancellous Bone Grafts for Infected Bone Defects: Single Stage Procedure, Surg., Gynec. & Obst. **83**:392-398 (Sept.) 1946.

tinued until the bone was consolidated. In 33 cases, the wounds were perfectly healed at the first change of plaster. The site and causative agent of the bone defects and the type of organism present are listed. The procedure was successful in 92 per cent of the authors' cases.

OSTEOMYELITIS

McClintock [1077] describes in detail the indications, measures and means which have been found successful in the treatment of exogenous osteomyelitis by saucerization and early split-skin grafting in several hospitals during the recent war. An illustrative roentgenogram and a photograph of a patient whose case was reported in a previous communication are included.

LESIONS OF THE UPPER EXTREMITY

Since the methods employed, the time required and the results obtained in the treatment of lesions of the upper extremity are so different from those in the treatment of lesions of the lower extremity, they should be given separate consideration. Such consideration has been given in 35 cases of lesions of the upper extremity, selected by d' Aubigne and others [1078] from 60 cases of war wounds in which there was loss of bone substance. One hundred thousand units of penicillin per day were given for two days before operation and continued after operation for three days after the patient's temperature became normal. It was considered indispensable for at least one month to have elapsed after complete closure of the soft tissues before any intervention on bone. Notwithstanding all the authors' rigid precautions, an infection with acute suppuration and extrudation of the graft developed five months after intervention. When strength of the graft was desired, cortical bone from the tibia was employed; otherwise, cancellous bone from the iliac crest or the upper portion of the tibia was utilized. The former were usually indicated in defects of the forearm. The fundamental essential for a successful outcome was considered to be pliable overlying soft structures, even though the condition necessitated excision of scar tissue, and a pedicle graft to fill in the defect. The use of osseous material favorable to rehabilitation, careful attention to the circulation and rigid fixation of the fragments are paramount in the treatment.

Uniformly curved and laterally displaced fragments of a soldier's right radius, which had been shattered by a machine gun bullet, persisted

1077. McClintock, J. A.: Reconstructive Surgery Following Treatment of Osteomyelitis by Saucerization and Early Skin Grafting, J. Indiana M. A. **39**: 436-439 (Sept.) 1946.

1078. Merle d'Aubigne, R.; Lance, P., and Zimmer, M.: Traitement des pseudarthroses diaphysaires, Semaine d. hôp. Paris **22**:1644-1652 (Sept. 21) 1946.

when the usual methods of reduction were attempted by Zaglio and Harris.[1079] Roentgenograms made eleven weeks after the injury showed no essential change in the fragments of bone when compared with those made twenty-four hours after the injury. There was limited flexion of the index finger and complete loss of pronation and supination of the forearm, necessitating surgical removal of displaced bone fragments and bridging of the defect with a tibial graft. At operation, approximately sixteen weeks after the injury, a false aneurysmal sac (or organizing hematoma) was observed to be separating the ulna and the displaced fragments. The postoperative course was uneventful; roentgenograms made four months after the operation showed clinical union of the graft. Six months after the operation, supination was complete, and pronation was 60 per cent of normal. The authors state that uniform deformity of a comminuted bone, observed soon after injury and persisting after the usual ordinary attempts at reduction, is cause for suspecting the presence of a false aneurysm.

Ghinst [1080] reports 4 cases in which the classic signs and symptoms of a syndrome of the sympathetic nervous system persisted after a fracture of the distal end of the radius had healed. All patients were relieved by injection of the sympathetic ganglions with procaine hydrochloride U. S. P. (novocain®). The injections were made twice each week over periods of two to four weeks. In 2 cases, the treatment was commenced five and eighteen months, respectively, after the injury. In the other 2 cases, treatment was commenced six weeks after the injury.

Fernandes Vocos [1081] describes how a combination of osteotomy, by the cubital route of approach, at the site of malunion of the distal end of the radius, and resection of the distal end of the ulna, to correct dysfunction, resulted in the restoration of supination and pronation and in otherwise improved function in the hand and wrist.

During World War II, unfavorable results of bone grafting operations for nonunion of the carpal navicular bone were reported by a number of authors. Murray,[1082] therefore, thought it advisable to report his results in 100 such cases: He experienced excellent results, with good function of the wrist, in the vast majority of cases.

The author states the opinion that certain principles must be followed to obtain the best results. Those he considers most important are con-

1079. Zaglio, E. R., and Harris, M. H.: Deformity of Radius Produced by Aneurysm: Report of Case, J. Bone & Joint Surg. **28**:635-638 (July) 1946.

1080. Ghinst, van der M.: Sur les séquelles des fracture de l' extrémite inférieure du radius et leur traitement, Bruxelles-méd. **26**:603-613 (June 9) 1946. 613 (June 9) 1946.

1081. Fernandes Vocos, A.: Fracture mal consolidada de la muñeca: su abordaje por vía cubital, Bol. y trab., Soc. de cir. de Córdoba **7**:250-264, 1946.

1082. Murray, G.: End Results of Bone-Grafting for Non-Union., J. Bone & Joint Surg. **28**:749-756 (Oct.) 1946.

cisely set forth. The proper selection of patients is emphasized. A few contraindications to the procedure are included. The time relations and the physical findings, as well as a summation of the functional outcome in the entire 100 cases, are listed in a single table. Roentgenograms from 4 cases illustrate the preoperative and postoperative conditions of the fracture site.

A method and technic for arthrodesis of the carpal navicular and capitate bone for nonunion of fractures of the navicular bone are given by Sutro.[1083] In the 4 cases in which the procedure was carried out, all patients had some loss of motion; in 1 case, bony healing was still lacking eight months after operation and nonunion, four years after.

Bone grafting in fracture of the carpal navicular bone by placing three bone pegs across the line of fracture is described by Cobey and White.[1084] Details of the method and clinical data, including case histories, are recorded.

Fontaine and Eck report [1085] 2 cases of fracture of the base of the first metacarpal joint, 1 of the Bennett type and 1 of the Rolando variety. In both instances, the fracture resulted from a bicycle accident. Lambotte screws were used to fix the fragments in position after open reduction. In each case, subluxation had recurred after removal of the plaster, which had been done after attempts at reduction and fixation in hyperextension, as advocated by Boehler. The Bennett type of fracture occurred in the case of a boy of 17, who presented the typical deformity and subjective symptoms so characteristic of this type of fracture. Three months after the accident, the fracture was reduced through an incision in the tabatière anatomique, exposing the fractured fragments. The fragments were fixed in position with Lambotte screws. Fixation in hyperextension until union was firm terminated in a satisfactory anatomic and functional result.

The Rolando variety of fracture occurred in the case of a carpenter of 35. There had been acute pain and total absence of function immediately after the injury. Roentgenograms showed a typical fracture at the base of the thumb, with subluxation of the Rolando type. A local anesthetic was administered, the fracture reduced, and a plaster of paris cast to hold the thumb in hyperextension applied. Twenty days later, roentgenograms and physical examination revealed that the subluxation had recurred and that function was greatly impaired. The fracture was

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1083. Sutro, C. J.: Treatment of Nonunion of Carpal Navicular Bone, Surg. **20**:536-540 (Oct.) 1946.

1084. Cobey, M. C., and White, R. K.: Operation for Nonunion of Fractures of Carpal Navicular, J. Bone & Joint Surg. **28**:757-764 (Oct.) 1946.

1085. Fontaine, R., and Eck, F.: Screwing as Treatment of Choice in Trapezoid-metacarpal Subluxations Complicating Fractures of Thumb of Bennett or Rolando Type, Rev. d'orthop. **32**:76-80 (Jan.-April) 1946.

reduced through an incision in the tabatière anatomique and fixed in position with one small Lambotte screw. Twenty-eight days later, physical and roentgenologic examination revealed an excellent result. Eight months after the intervention, the function was normal. The authors list statistics given by Imbert and Cottalorda on permanent partial disability: In Bennett's fracture, such disability occurred in 5 to 10 per cent of cases and in Rolando's fracture, in 20 to 30 per cent.

The tenon and mortise type of tibial graft was applied by Morris [1086] to bridge metacarpal defects due to gunshot wounds in 6 cases. The grafts all united satisfactorily, and there were no complications. Tibial cortex is used because it is considerably stronger and more suitable for shaping to replace lost segments. The tibial graft is made sufficiently long to bridge the gap and to allow a tenon 1.5 cm. long on both ends. One tenon is fashioned to fit snugly into the medullary cavity of the proximal fragment, and the distal tenon is inlaid in a slot made on the dorsal aspect of the distal fragment, where it is fixed in position with number 31 stainless steel wire.

INJURIES TO THE JAW

The use of bone grafts for the remedy of defects of the mandible is a by-product of the first world war. Prior to 1916, only occasional isolated attempts at mandibular grafts were reported. From available figures, approximately 1,000 mandibular bone grafts were reported by workers in all countries from 1916 to 1922.

Between the two wars, defects of the mandible requiring bone grafts were limited to sporadic instances here and there. Owing to prompt and routine application of new methods and materials during World War II large numbers of patients with extensive injuries to the lower part of the face survived.

Blocker and Weiss [1087] report 43 cases in which cancellous bone grafts were successfully taken from the ilium to bridge defects of the mandible, from 3 to 12 cm. in length, and 9 cases in which defects of the maxilla were remedied. The 52 cases were selected from 457 cases of defects of the upper or lower jaws.

It is emphasized that the treatment of bony defects of the jaws must be planned on a basis of long time preparation for the grafting. Elimination of infection, removal of sequestrums and broken fragments of teeth and the remedying of soft tissue defects before surgery is attempted are essentials. The article includes a brief history of mandibular graft-

1086. Morris, H. D.: Metacarpus-Tenon and Mortise Grafts for Bridging Defects Due to Gunshot Wounds, Surgery **20**:364-372 (Sept.) 1946.

1087. Blocker, T. G. Jr., and Weiss, L. R.: Use of Cancellous Bone in Repair of Defects About Jaws, Tr. South. S. A. (1945) **57**:153-169, 1946.

ing and the detailed accounting of the types of bone used, plans of treatment, methods of fixation, operative technic and postoperative care; reports on cases follow.

Administration of testosterone propionate for the purpose of encouraging callus formation in a case of fracture of the mandible in a football player is reported by Schmid.[1088] There was no evidence of callus formation after forty-seven days, and roentgenograms showed that the fragments were pulling apart. According to the advice of European authors who had successfully used androgen therapy in the treatment of fractures when callus formation failed to occur in response to the usual methods, three "linguettes," totaling 5 mg., were administered per day for fourteen days. Roentgenographic examination then showed distinct callus formation, and the patient stated that the jaw felt more firm and that he was able to eat harder foods. [ED. NOTE.—The failure of callus to appear in a case of fractured mandible in forty-seven days is not unusual.]

PSEUDARTHROSIS OF THE CLAVICLE

Støren [1089] reports a case of pseudarthrosis following fracture of the left clavicle in a woman of 39. The condition had existed for twenty-six years without subjective symptoms. Three years prior to the first examination by the author, severe pain developed in connection with the patient's lifting another woman. For some sime, the pain came on only when she was at work and persisted for a short period after work had ceased. Later the pain, characterized as intolerable, became persistent and was not influenced by various physical therapy measures. The pain was repeatedly localized to sharply defined areas on the back of the upper arm and the forearm. Subcutaneous vasomotor changes, consisting of tenderness, hyperemia and induration, were present in the two areas.

Roentgenograms revealed a pseudarthrosis at the junction of the middle and outer thirds of the clavicle, with considerable upward angulation of the fragments. An attempt to produce osteosynthesis by drilling and by fixation with wire sutures relieved the pain for only four weeks, union failing to occur. A second operation, which consisted of placing a tibial graft with two "bridgeheads" across the clavicular defect, was then performed. The graft was fixed in position with a metal suture. Bony union, accompanied by the disappearance of all the objective and subjective symptoms, followed.

1088. Schmid, H.: Favorable Effect of Testosterone Propionate (Androgen) on Callus Formation in Case, Schweiz. med. Wchnschr. **76**:538 (June 15) 1946.

1089. Støren, H.: Old Clavicular Pseudarthrosis with Late Appearing Neuralgias and Vasomotor Disturbances Cured by Operation, Acta chir. Scandinav. **94**:187-191, 1946.

Figure drawings to show the areas of localized pain with vasomotor changes, one diagrammatic drawing of the "bridgehead" graft employed, and preoperative and postoperative roentgenograms illustrate the presentation.

[ED. NOTE.—In dealing with pseudarthrosis of the clavicle, it should always be remembered that congenital defects of this bone are one of its prime characteristics. Such defects may vary in degree from those which are slight, amounting to a false joint, to those in which most of the bone, as well as part of the sternum, may fail to develop, as seen in congenital craniocleidodysostosis. Congenital defects of the clavicle are commonly bilateral. Their explanation is probably that the sternal end of the clavicle is formed in membrane, while the outer end is enchondral bone.]

POST-TRAUMATIC CONTRACTURES

Using the Sherrington pattern of "decerebrate rigidity" on cats whose brains were separated in the region of the tentorium Speranski [1090] employed various methods of producing irritation in the extremities in an attempt to explain post-traumatic contractures. Both central and peripheral irritation were investigated. Prolonged observation revealed intermittent relaxation of the spasticity, not only in the affected limb but also in the homolateral one. The author concludes that this phenomenon can be explained only by the fact that the irritation spreading through the nervous system is of a reciprocal character, involving the neural segments.

1090. Speranski, A. D.; Post-Traumatic Contractures, Am. Rev. Soviet Med. **4**:22-24 (Oct.) 1946.

CORRECTION

In the article by Henry Milch, M.D., on the "Short Radius" in the October issue of the ARCHIVES, page 856, the quotation from Anton, Reitz and Spiegel should read "idiopathic, progressive curvature of the radius due to a dyschondroplasia of the inferior radial epiphysis resulting in a deformity of the wrist giving the appearance of an anterior (or more rarely a posterior) subluxation of the hand."

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